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AVIATION AND COSMONAUTICS

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[The following are translations of selected articles in the Russian-language monthly journal AVIATSIYA I KOSMONAVTIKA published in Moscow. Refer to the table of contents for a listing of any articles not translated.]

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Roundtable Discusses Problems in Flight Training
92UM0898A Moscow AVIATSIYA I KOSMONAVTIKA
in Russian No 12, Dec 91 (signed to press
17 Dec 91) pp 2-3

[Report by Major N. Starodymov on editorial roundtable discussion under the rubric "Military Reform—Problems and Judgments": "More Questions Than Answers"]

[Text] *The participants in today's discussion do not know each other. But they are all pilots, and are linked by their desire to make their own contribution to the renewal of the cause to which they have devoted their lives. The genre of this feature could thus be defined as a correspondence "roundtable" of the editors. The topic of discussion is one of the chief aspects of military reform in aviation—improving the flight training of the aerial warriors.*

Lieutenant-Colonel S. Smirnov, deputy regimental commander (TurkVO [Turkmen Military District]): Recent events in the Persian Gulf region are the most visible confirmation of the increased effectiveness of the use of aviation. The success of the multinational forces was entirely pre-ordained by the broad-scale operations of the air forces. Are our capabilities comparable to those that were displayed by our colleagues from the armies of the NATO countries?

Let us debate this further. We know that our aviation industry has created excellent combat aircraft that are superior in many parameters to analogous types of foreign-made aircraft. Ever greater requirements are also being posed today toward pilot training with the development of the hardware. But are we fighters, so to speak, keeping up with scientific and technical progress?

Even an uninitiated person, for example, knows how difficult it is to detect a target on the terrain from the air, I think. To what extent is our, figuratively speaking, "average" pilot prepared for visual search? The level of training here is unfortunately not subject to generalization, since it depends more on subjective factors than on the techniques of combat training. The chief misfortune is that many deviations from the rules are founded on imperfections in the structure of the teaching process and the procedure for completing service as a military pilot themselves, and about the renewal of which more than one generation of pilots has dreamt.

We simply do not look after the cadres. As long as the pilot is flying, the romanticism does not leave him. But then he receives the rank of Major. And here, among the officers, there occurs a demarcation between the "promising" and the "unpromising," which is naturally later reflected in the fate of each. Under those conditions it is not difficult to make a choice, forecasting the prospects for professional growth. Since the pilot "racks up" service time allowing him to be discharged into the reserves somewhere around 32 years, not many are agreeable to fighting for a career. That is, it is namely at the time when the pilot becomes a genuine professional

that we lose him. I would add here that the younger ones are "pushing him" from below, and you will agree that the system itself pushes experienced pilots to decide on early retirement from the armed forces. And the problem, after all, could have and should have been solved by the state long ago! The way out that is seen is a rudimentary one—we must give the military pilot a vested interest in serving, say, up to 45 years. The smallest bit is needed for that: let the service time have, within reasonable limits, a proportional effect on the size of the pension therein. It has come to this—an outflow of pilots in the prime of life "for medical reasons" is depriving the Air Forces of true professionals. And that is a misfortune.

There is another problem. The experience of operations in Afghanistan is little used by the pilots in combat training. How was it there? The pilots were given target coordinates, and in ten minutes the aircraft were already going off. The mission was virtually always performed, despite the extremely low, according to our "union" standards, time to prepare. How was the success achieved? The chief constituent of it, in my opinion, was the fact that one indispensable condition was, in the first place—the correspondence of the nature of the preparatory work to the interests of the fulfillment of the combat mission. They were occupied with the details only for the purpose of instructing the less-prepared pilots. The constant opposition of the two "pillars" of aviation—flight safety and combat training—is evident under peacetime conditions. And priority is assigned more and more often namely to safety. Poor results in combat training can be excused year after year, but that is not the case for a flight accident—any precursor to one entails instant sanctions.

Captain V. Fenin, deputy squadron commander (TurkVO): I made 300 sorties in Afghanistan over 13 months—that is, the combat work was going on virtually every day. This was not for show or for teaching in the usual understanding of the word. Mechanical memory was nonetheless working to the full extent—the actions at takeoff and landing were practiced until they were automatic. Everyone learned in excellent fashion how to orient themselves not only according to instruments, but also according to the ground or the lead man. We were surprised at first—why were there so many fewer mistakes, precursors to accidents or accidents themselves? I understood later that they trusted us, they did not reproach us for trifles, they did not foist office instructions on us. Under everyday peacetime conditions they think more about the observance of standards than about business. Here I am entirely under the power of restrictions. To whom is it advantageous to make of us people who are psychologically oppressed by prohibitions and playing it safe?

And perhaps it is safer for me personally to act differently in the very same landing, but what will happen then?... We went to Afghanistan as novices, and believe me, we did not know how to conduct ourselves as a concrete person in a combat situation, deprived of

initiative and flight individuality. Our system, as you can see, does not want to cultivate any Chkalovs...

I dream of creating an experimental regiment. Give the people there the opportunity to bring to life intelligent ideas, and free them of the necessity of doing excess paperwork. It is time to recall that pilots make flights, the sky, and not papers!

And there were instances in Afghanistan when the pilots bailed out of damaged planes and helicopters and landed in a ring of rebels. Another serious omission in the training of the crews then made itself felt—most of us, having more or less successfully mastered aviation weaponry, are very mediocre at hitting targets with firearms, not to mention the ability to wage hand-to-hand combat. More than a little significance would be assigned to these military disciplines in the experimental regiment I dream of.

One often has to hear, "You are not just a pilot, but first and foremost an officer!" That is how they justify the obligation of pilots to go on details, to be the senior responsible for subordinates on housekeeping teams. Who needs that? Us? Our professionalism? Combat readiness?...

I will not conceal the fact that it was tough in Afghanistan. But I felt myself a pilot there. There I was flying, and here I am fulfilling the requirements of standards.

Major P. Kazachenko, military pilot/instructor (ZakVO [Transcaucasus Military District]): One need not approach an evaluation of the process of training flight personnel from the standards of actual battle in order to see the patent absurdity of its organization. It should be said that clear contradictions exist today in the system of combat training for the flight personnel of fighter-bomber aviation. The Combat Training Course—that is, the fundamental document governing the training of pilots—would seem at first glance to entirely assume, and even stimulate, high levels of their training. It envisages, after all, a program of improving the pilots in the most complex types of training—flights using expert-level aerobatic maneuvers, landing approach at minimum ceilings etc. What else could the pilot dream of, it seems? All roads to the improvement of skills are open! But... You become convinced in your encounters with reality that all of these good things are just declared on paper. The system of bureaucracy, the system that has for years smothered such qualities of officers as the absence of ordinary thinking and initiative, the system that facilitates the welfare of careerists, the ungifted and the play-it-safe crowd, hinders the incarnation of all of the requirements that are set forth in the course.

Take, for example, the principal subunit of any aviation regiment—the squadron. Its commander is vitally interested in the fine-tuning and combat readiness of the military collective subordinate to him. But various guardian officers are standing over him, there is such a knot of "directives" making so many requirements of

him from all headquarters and levels of authority, that he ends up bound hand and foot by reading them alone.

One cannot observe without a shudder, for instance, the picture of the planning of flights for the next day. The distribution of aircraft and instructors proceeds deep into the night. And suddenly a call "from above": "Tomorrow I'll be flying with you, plan so many flights!" And everything starts all over again, with cursing and nervous strain...

And the running of "their own office!" Before the flight the pilot should have filled out the "Notebook of General Preparation" for the given kind of flight, the "Notebook for Immediate Preparations for Flight," diagrams of the flight assignment with a listing of the technique for performing it, safety measures, rectification of deviations and some other documents. But let's think about it—can the filling out of this clump of documents really be all that necessary for flight preparations? I will judge from myself—after such orthography lessons I was not up to a creative interpretation of the flight. This time could have been spent more efficiently in the cockpit of the aircraft, in a simulator, practicing the scenarios, bringing one's actions to the level of automatic and the model of behavior to perfection.

The result of our flights are now evaluated at a certain level according to only two basic indicators—the absence of precursors to flight accidents and the "correctness" of the paperwork. The idea thus gradually takes shape in the consciousness—are all these flights necessary at all? It would be more peaceful without them, after all...

Lieutenant-Colonel V. Dzhabua, student at military academy (MVO [Moscow Military District]): I would like to formulate some proposals for raising the quality of training of the contemporary combat pilot. He should, first of all, be completely shielded from social and domestic problems both in the service and at home. His work will scarcely be sufficiently effective if he has nowhere to get a good sleep the night before flights, if he is tormented with thoughts of firewood for his little stove or about hungry children.

We have to stop the paper flow that our military aviation has been swamped with. A single log of the squadron commander and the flight booklet with an album of diagrams of the flight assignments for the pilot, in my opinion, is enough for the successful preparation and organization of flights. That is all! And to ask the commander, "Why simplify?" rather than "Who permitted that?"

As concerns morale and psychological preparation, the pilot should be glad about the impending flight, and not apprehensive about it (if only nothing happens...) If the pilot is trusted (and how can he be let out to fly otherwise?), then he should prepare for the flight independently, without petty oversight. He only needs a little help at the time—and professional pride will awaken in the flier. Flight skills, I have no doubt, will be raised to a new level accordingly.

I am asserting this not proceeding from some abstract conceptions, but rather based on observations made in the unit where I used to serve. No few complex assignments were passed on to our officers to perform, operating day and night, under conditions of high mountains or over the ocean. I recall a case where our unit was redeployed a large distance, with an intermediate night landing at an unfamiliar airfield for refueling in the course of exercises. The first aircraft had scarcely landed when the runway illumination was extinguished. Landing under such conditions was not a simple matter. I can say boldly that only a pilot confident of his actions is up to it. And the fact that there were many such people in the unit is to the credit of our commanders, who without looking over their shoulders at the "higher-ups" had taught us without indulgences. We did not know then what interruptions in flying were. There were no serious precursors to flight accidents in any case. But... that was before. The leadership changed, and the principle of "what is that needed for?" predominated. And today there is no longer that former level of flight training among the pilots, the inclination to fly has been driven out of them. And if there is no desire, where can mastery come from? The subjective factor, as we see, still rules the roost in aviation.

Captain A. Shalygin, senior pilot (DVO [Far East Military District]): I feel that unique centers, skills-enhancement courses and the exchange of experience should be organized for the pilots. Aviation is developing rapidly—theory, hardware and tactics are being perfected... The pilot should thus constantly be renewing and expanding his knowledge both of his own Air Forces and of the air defenses and aviation of other nations.

I am a patriot, but I should say directly that we could not have operated as crisply in the Persian Gulf as the Americans. The over-abundance of instructions does not yet permit us to reach their level. We will be honest at least to ourselves. Such a situation has also taken shape because the American pilot, for example in Vietnam, received 1,500 dollars for each combat sortie, while in Afghanistan our work was valued at a ruble and a half a day. It is thus too early to say that professionalism in the Air Forces is a *fait accompli*.

Captain A. Kabanin, deputy squadron commander (SGV [Northern Group of Forces]): I am troubled by the question of resurrecting the traditions of domestic aviation. When you look at the frames of films from World War II, your attention is frequently drawn to the symbols that adorned the fuselage, tail or wings of both our own and foreign aircraft. I think that this practice of individualization, in counterpoise to the army "lack of personal responsibility," should be resurrected. The first step in that direction has already been taken here, in the SGV—there are now pictures of bears on the sides of the heavy transport helicopters. Now we have to go further and manufacture the corresponding emblems and patches for the flight uniforms. That, I think, would cultivate among

the servicemen a pride in their affiliation with aviation and raise the prestige of their profession in the eyes of the people.

As far as I know, by the way, various formations of the Russian army have always had their own emblems. Why shouldn't we resurrect that fine tradition in all branches of the armed forces and arms of the troops? After all, any unit still has no distinctions other than the Red Banner, which far from all soldiers see uncovered over two years of service.

And last. It cannot be forgotten that social and domestic problems often lie at the heart of service disorders. Each of us knows that if something happens to the pilot, no one needs his family. That is a bitter truth. The children are left without a father, the family without an apartment, and you won't stretch the pension (as, by the way, the salary) of the pilot alone very far today.

From the editors. *One can probably not agree without argument with all of the participants. But our times are interesting for the fact that each may defend his own opinion and submit it to the court of public opinion. And there is one criterion of truth here—competence.*

Yes, it is not only highly placed and authoritative people who are debating the problems of military reform today. The servicemen of the "lower" echelons are being more and more broadly included in this process. It seems that this is a reliable pledge of the fact that the person in shoulder boards will enjoy popular love and respect in the future as well. He is worthy of that. But is his opinion being taken into account in selecting ways of renewing army life?

But there are still more questions on military reform today than there are answers...

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American, Soviet Combat Helicopters and Development Plans Compared

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[Article by Candidate of Technical Sciences Colonel (Reserve) G. Kuznetsov under the rubric "Military Reform: Problems of Army Aviation": "Lagged Behind. A Lot or Forever?"]

[Text] A set of measures to implement the "Army-90" program, which envisages the modernization of the ground forces, is being broadly pursued in the United States. Its principal aim consists of sharply raising their combat capabilities and achieving the ability of waging active combat operations in contemporary warfare for a prolonged period of time through technical re-arming and a review of the standard organizational structure of the units and formations.

Army aviation (AA), the principal might of which consists of helicopters intended for the performance of combat and rear-support missions for the ground troops, is also to be further developed under this program.

The American helicopter-building companies, taking into account first and foremost cumulative experience in the combat utilization of rotary-wing craft, have been doing work aimed at increasing their lift capacity and flight speeds and ranges, their degree of protection against the fire of field air-defense weapons and their sophistication in technical equipment and armaments systems. This has made it possible with time to give complex tasks to the crews of the combat helicopters—fire support for armored and other vehicles, suppression of air defenses (first and foremost air-defense missile systems), destruction of enemy helicopters in the air and the performance of various types of aerial reconnaissance, among others.

It is not difficult to suppose that our developers of new prototypes of combat aviation hardware adhere to concepts of the development of army aviation similar to those of the Americans. An analysis of the results that have been achieved by both countries in this realm, based on the example of comparing the principal tactical performance characteristics of helicopters that are close in their intended purposes, is of definite interest in this regard.

The fundamentals of the tactics of combat operations for AH-64A helicopters performing their missions in close interaction with the OH-58D reconnaissance helicopter (a craft for the analogous purpose has not yet been

created in our country) in comparison with the capabilities of the Mi-24 and Mi-28 helicopters have been considered before (AVIATSIYA I KOSMONAVTIKA, 1990, No. 8), and it would thus be superfluous to dwell on the obvious technical and tactical superiority of American combat helicopters over Soviet ones.

As concerns an evaluation of the capabilities of the UH-60A and Mi-8MT helicopters in their provision of aeromobility for assault units, shipments of matériel, evacuation of wounded, performance of aerial mining and other specific missions, one can speak with certain allowances of their rough equality.

Thus, despite the large lift capacity of the Mi-8MT for its class (achieved, by the way, through larger dimensions than the UH-60A), its enhanced optical, radar and infrared detectability is considered to be a substantial drawback that leads, under conditions of strong enemy air-defense opposition, to significant combat losses.

The Americans solved the problem of expanding the volume of air shipments by increasing the fleet of transport helicopters. They moreover took into account one circumstance that is of no small importance—the loss of one such (comparatively inexpensive) craft in the course of combat operations brings relatively less economic harm than the loss of a heavy-lift helicopter.

Analogous conclusions are also suggested as the result of a comparative assessment of the capabilities of the CH-47D and Mi-26 in the transport of combat vehicles and weaponry for the ground forces. The same drawbacks—larger dimensions and enhanced detectability—that are typical of the Mi-8MT, after all, are also typical of the Mi-26 (even though this craft is in a different class). It moreover lacks an on-board system of protection against missiles with thermal guidance.

Data on helicopters and their armaments	AH-64A	Mi-24
Static ceiling, meters	3,600 (+)	2,100 (-)
Maximum G-forces	3.5 (+)	1.8 (-)
Surveillance and targeting system:		
—daytime surveillance television channel	two fields of view (+)	lacking (-)
—television channel for surveillance in bad weather and at night	three fields of view (+)	lacking (-)
Passive system for protection against missiles with thermal homing heads	installed (neither inferior)	
System for guidance of portable antitank missiles	automatic with laser illumination (+)	semi-automatic radar (-)
Cannon-gun armament	movable 30-mm cannon (+)	mobile 12.7-mm cannon (-)
Laser rangefinder	installed (+)	lacking (-)
Guided air-to-air missiles	installed (+)	lacking (-)
Non-guided missiles	installed (neither inferior)	

The modernization of the whole fleet of combat helicopters is currently proceeding apace in the United States. Work is underway, for example, to increase the power of the AH-64A power plant and to fit that rotary-wing craft with air-to-air guided missiles and new communications equipment with, as in the case of the analogous equipment for the ground forces, a unified channel for the

support of command and control and coordination. The on-board installation of the latest weapons-control system is also planned.

The creation of a new family of light combat helicopters (LCH)—whose development is underway within the framework of the LH program—is a most important

stage in the development of army aviation, in the opinion of American specialists. It is felt that the LCHs should complement to the full the combat capabilities of the AH-64A. The reconnaissance helicopter created on the basis of the LCH will differ from the OH-58D through more advanced reconnaissance equipment, increased survivability and the ability to detect and strike with surprise at especially important targets on the battlefield. Finally, a fighter-helicopter intended for waging air combat is being created for the first time on the basis of the LCH. The development and creation of the LCH, which is being conducted on a competitive basis, is planned to be completed by August of 1993, with the start of deliveries to the line units in November of 1996.

A powerful combat link is thus being created in United States army aviation—strike, reconnaissance and fighter helicopters—that will undoubtedly be able to operate effectively under the complex conditions of modern battle. Its placement into service will make it possible for the American command to make an optimal combination of the capabilities of these helicopters in the course of combat operations.

A program of further improvement in the UH-60A and CH-47D helicopters is also projected. The improvement of their tactical performance characteristics and the installation of new on-board equipment, for example, is being planned simultaneously with the increase in their numbers.

Helicopter data	Transport and assault-transport helicopters		Cargo and transport helicopters	
	UH-60A	Mi-8MT	CH-47D	Mi-26
Static ceiling, meters	3,170 (+)	2,700 (-)	2,680 (+)	1,800 (-)
Maximum speed, km/hr	296 (+)	250 (-)	297 (not inferior)	295 (not inferior)
Maximum cargo capacity, kg:				
—in cargo cabin	1,200 (-)	4,000 (+)	8,165 (-)	20,000 (+)
—on external hangers	3,630 (+)	3,000 (-)	12,700 (-)	20,000 (+)

The prospects for the development of U.S. Army aviation are apparent, as we see. But what awaits our own, domestic aviation?

I would remind you, first and foremost, that the first flight of the Mi-8 helicopter was back in 1962, almost thirty years ago! Its modernization has by now been completed, and an entirely natural and logical question thus suggests itself—where is its replacement?

The question of adopting the Mi-28 helicopter into service—with its combat potential even today inferior to the AH-64A (see AVIATSIYA I KOSMONAVTIKA, 1990, No. 2) and its series production, by the way, coming to a conclusion—is being decided today. The “new” craft will consequently in no way solve the acute problem of raising the combat might of our army aviation to the level that is necessary to ensure the sound protection of the nation, as the defensive military doctrine requires.

I would like to direct attention in this regard to the comprehensive consideration that must be displayed in resolving the issue of cutting back defense spending. I feel that military programs that have a defensive thrust, including the creation of aircraft that are not inferior to foreign analogues, should be financed first of all.

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Flaws in Training for Military Transport Aviation
92UM0898C Moscow AVIATSIYA I KOSMONAVTIKA
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[Article by Candidate of Military Sciences Lieutenant-Colonel (Reserve) V. Shishkin under the rubric “Combat

Training: Experience, Problems, Opinions”: “A Hope Undimmed With the Years”]

[Text] Judging from the letters that have come to the editors, readers were not left indifferent by the article of Lieutenant-Colonel V. Vysotskiy entitled “The Stumbling Block, or The Problems of Combat Training” that was published in the last issue of the journal. Negative phenomena have also not skirted military-transport aviation, about which a great deal of complimentary things have been said of late—the fliers are great guys, they say, they are earning additional funds to finance combat training and to solve accumulated social problems! However... One has to hear more and more often, with a note of sarcasm, the acknowledgment of the laborers of the sky that nothing has changed in recent years, everything is as it was before... So just what is keeping us from cutting through the tight knot of problems in flight affairs? Candidate of Military Sciences Lieutenant-Colonel (Reserve) V. Shishkin, who has devoted thirty years of his life to service in VTA [military-transport aviation], expresses his own opinion within the framework of the debate that has been opened on the pages of the journal.

A person who is familiar in passing with the specific nature of the profession of military pilot probably assumes that he spends the greater portion of his working time in the air, performing various assignments. All correct with just one reservation: not in the air, but rather on the ground with a pencil in hand. Paperwork, as has already been mentioned in the article “The Paper ‘Werewolf’” (AVIATSIYA I KOSMONAVTIKA, 1991, No. 5), has swamped everyone in aviation, from the pilots to the technicians, but the commanders especially

get it. Ask any of them what hinders them the most in their work. Without thinking they will answer you—the paperwork. It corrupts the operational thinking of the pilots, detains their memories and accustoms them to slowness. The wits even joke about it—“The scratching of the pens drowns out the hum of the turbines.”

All flight preparation, in the unanimous acknowledgment of the pilots, is permeated throughout with formalism, and is reduced just to filling out documents necessary for the performance of group monitoring of readiness, and not for the fulfillment of the concrete flight assignment. The paper routine leaves no time for the mental playing out of the flight or the conducting of simulations... Such a clumsy, bureaucratic nature of the organization of preparations for flights and the utter monotony of their performance, added to the worsened social problems—all of this, in the opinion of the fliers, causes the loss of any interest in flight work as a result. And as bitter as it may sometimes be to recognize, facts remain facts—aviation is being deprived of professional pilots who have, over the years, become disillusioned with the profession they once chose.

There is another element here of no small importance. Do we often, having studied the content of the latest “guiding” document, take a critical approach to the fulfillment of its requirements? Just do not think I am calling for them to be ignored. I am not asking an idle question here, since a dangerous—that’s right, dangerous—trend toward the unbelievable “ballooning” of all possible instructions and regulations has been noted of late. The impression is being created that someone (perhaps the leadership of Combat Training?) has set the aim of issuing instructions for every instance in life. But as they say, you can’t provide for everything. And the immediate executors—the pilots—suffer as the result of this “concern” due to their informational and emotional overloading.

“Correct” instructions (they are written by people who are probably also “correct”) always abound in unequivocal directives that are more suited for a robot than for an intelligent person. Aviation medical personnel, for example, feel that the blind subordination of the pilot’s activity to such unequivocal prescriptions leads to his transformation into an indirect appendage of the aircraft. It has been established that one of the causes of flight accidents is a “standardization of the pilot’s thinking.” In the opinion of American aviation specialists, for example, a surplus of information proves to be no less harmful than a shortage of it. Proceeding from this, they subject the whole stream of documents coming to the flight personnel to a careful “filtering,” and select from them only those that are really essential to the flier in his practical activity.

I will cite this example as proof of the contradictory nature of some of the provisions of the guiding documents. It was at one time written in black and white in the instructions for the crew of the An-12 aircraft (we will compare only two excerpts from the instructions)

that “...at great flight weight the landing must be executed with the engine control levers (RUD) at the forward latch (for the creation of increased engine thrust),” and “in a strong crosswind the flaps are not fully extended.” The wise developers of the instructions, however, evidently did not take into account that a landing could be performed both with a great flight weight and in a strong crosswind. It thus turns out that the pilots, indoctrinated by the System in the spirit of unswerving (read—unthinking) fulfillment of the requirements of the instructions, would perform the landing in such cases “as they were supposed to”: RUD at the forward latch and the flaps set at an intermediate position. It is not difficult to guess what this led to—enormous overshooting and the breakage of aircraft.

Few probably know that with the start of the entry of the Limited Contingent of Soviet Troops into Afghanistan, the first of our combat losses were not among the assault troops or the motorized riflemen, but rather among the VTA crews. Their lack of suitable experience in flights in mountainous terrain led to collisions of aircraft with mountain peaks. And how can pilots be considered ready for such flights if, according to the KBP [Combat Training Course]—in the development of which such outright dilettantism was permitted—permission for flights with landings at unfamiliar airfields (regardless of their specific features) was given after one check flight by day and one at night? But what if the airfield is in the mountains?

How can one fail to recall here the incident with the demise of the crew of an Il-76 that had delivered cargo to the residents of Armenia who were stricken as the result of the destructive earthquake?! The cause of that aviation catastrophe was the same—the professional under-education of the fliers. And it is not the pilots who are to blame here, but rather those who had trained them and who had developed their training program.

And a word, by the way, about those who are doing the “developing.” Meditating often about the problems of flight matters, I have mentally asked myself each time the question of whether the level of development of the technique of flight training of crews corresponds to the scientific level at which the modern aircraft are being created. On the one hand, after all, is great science, and on the other is a cottage industry, primitivism and the most total insolvency. An example is needed? Fine. One of the collectives of researchers at the center for the combat application of VTA was “headed” for a number of years by Colonel V. Shabayev, who had earlier been removed from the post of chief of the political department of a large formation, and who not only did not know how, but did not even want, to work fruitfully in his new capacity. In addition to all this, this “supervisor” was not in tune with the laws of flight service, and for that reason often committed gross deviation in piloting technique that were unforgivable for a person of that rank. Colonel V. Shabayev was ultimately removed from this crucial post soon enough as well. The state of affairs also did not change for the better with the coming of

Colonel V. Cheprakov to the collective (who was also, by the way, a "former" commander of an aviation regiment).

One can only marvel at how cadre issues are resolved here—people whose level of professional training is considerably below that of their subordinates are sometimes designated for the position of scientific supervisors. They are not named as recognition, but rather as patronage from above. Matters suffer as a result of such personnel combinations.

I would also like to dwell on another paradox that has taken shape in the organizational and technical sphere of supporting the process of combat training for military aviation.

Have you ever been in the planning room of an aviation unit, that gallery of flight documentation? Schedules on the walls, colored diagrams, flight schedules... Red and blue circles, squares, flags everywhere... "Flight files" for the pilots, so to speak, initial material for planning their flight preparations.

So then where, you ask, is the modern computer equipment able to free up the person from routine work and raise the efficiency of his labor? There is such equipment—there is a digital computer on board the aircraft—but at the pilot's side is the wooden "computer"—the NL-10M plotter.

One and the same answer came from the Main Staff of the Air Forces to all of my attempts to set forth concrete proposals for the adoption of personal computers into the process of planning of preparing for flights: "We agree, but there is no funding, the use of the Luch-84 system for the automated flight data processing is planned for this purpose." One can, of course, also drive nails with an electric iron and crack nuts with a crystal vase. But wouldn't it be better to use these items, and the system, for their direct purposes, including to train the flight personnel in performing a competent analysis of their own mistakes in piloting and operating the aircraft?

As pertains to the search for the necessary financial resources, a real opportunity for outfitting the aviation units with modern training equipment has appeared with the start of widespread commercial activity by VTA. Many could object—first let's think about our daily bread, and later... I agree that we are severely short of bread, housing and everything that is needed for normal human life today. But I think that it is nonetheless not worth getting locked into the solution of social problems alone. Man does not live by bread alone. It is essential, as difficult as it may be, to adopt the latest achievements of science and technology immediately in order to turn the existing system of flight training toward the pilot—which, taking into account the exceptional expense of flight training, is economically justified first and foremost.

The "tape recorder" principle of training has currently become solidly established in the training of fliers—the

pilot has to memorize a certain volume of information and "reproduce" it correctly when being checked for readiness for flight. It is obvious that this approach leads only to the intellectual degradation of the personality of the trainee.

It is generally acknowledged that the pilot's ability to make a competent decision in a concrete flight situation based on foresight of the prospects for its development is at the focus of professional training for the pilot. The use of computer technology in the process of flight training, from that point of view, will make it possible to employ the principle of an individual approach to the pilot to the full extent, and make it possible to concentrate the principal attention on the specific drawbacks in his flight training and eliminate from his personal program of emergence the elements of flight assignments he has practiced well. And that will lead in turn to a considerable economy of the material resources being expended to support the combat training of fliers. I would remind you that just one hour of flight time on an Il-76 aircraft costs the state—i.e. you and me—eight-plus thousand rubles, wherein about 9,000 kilograms of expensive fuel are consumed.

What does it mean to utilize economic methods in flight training? It means, first and foremost, to perform the mandatory accounting of all funds being expended for the training of each specific crew member and to provide an objective assessment of his professional suitability for further flight training (the mastery and state of health of the flier should be the principal criteria for that assessment).

The time for cottage industries and dilettantes in flight training, I hope, has irreversibly passed. We must count well in order to economize in earnest—something the aviation bureaucrats are avoiding in every way possible, not wanting to make things any harder for themselves thereby. I feel that it is not shameful in this regard to copy the experiences of the air forces in the NATO countries, where they know how to count money and thus consider each pilot to be an "object" into which a respectable amount of capital has been invested and where they try to provide incentives for his long flight career by various means. They prepare a professional, in other words. Such an approach, pragmatic at first glance, proves to be far more humanitarian as a result compared to the leveling that has spread rampantly like a weed in the favorable soil of our archaic System. God save you if you say anything against the ritual that has been established for years—you will become anathema at once (where necessary it is always possible to find some flaw in the flier and write him out of flight operations). In order to have the opportunity of doing at least something the way they want, most are forced to express themselves, like everybody, using slogans (such as "Every missile, bomb and shell—on target") and fine promises ("Serve according to regulations and you will win honor and glory").

A system of protection against dangerous mistakes by crew members in the techniques of piloting and operating aviation systems, which the wits have dubbed "idiot-proofing," has been installed on many types of modern aircraft. The time has evidently come to envisage a system within the standard organizational structure of our Air Forces to protect those who think differently against the dictate of the aviation bureaucracy that possesses unbounded administrative authority...

I am convinced that there is no one among the fliers who is indifferent to the unsolved problems of combat aviation. Will they be solved? It remains to remember the ancients—where there is life, there is hope. I hope that, in turning away from the old dogmas, we will nonetheless achieve a resurrection of the lost prestige of the profession of military pilot.

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Letters to Editor

92UM0898D Moscow AVIATSIYA I KOSMONAVTIKA
in Russian No 12, Dec 91 (signed to press
17 Dec 91) pp 8-9

[Reader letters to AVIATSIYA I KOSMONAVTIKA]

[Text]

If There is No Interest in Learning

The presence of a striving to become aware of the new among trainees is one of the chief conditions of the successful completion of the training and upbringing process (UVP), and testimony to its correct organization. A cognitive interest not only facilitates the development of the intellect, but is also a motive force for improving the personality overall.

An anonymous questionnaire for the graduates of the VVAIU [Higher Military Aviation Engineering School] on this problem has shown far from encouraging results. To the question of "Do you have interest in studies?" some 53 percent of those polled gave a positive answer, 24 percent negative and 23 had not determined their attitude toward classes. Only slightly more than half of the cadets thus have positive motives toward studies, while the rest are indifferent toward them or are not interested in them. Whence the quality of the studies...

An analysis of a similar questionnaire in the secondary schools showed that, even there, more than 20 percent of the students did not like their subjects, textbooks or teachers. And one could complain that the interest of the cadets in study was suppressed back in school, although, on the other hand, that opinion does not coincide with the love of knowledge and natural curiosity of the young mind. The shining eyes of the first-year cadets (and the more so first graders) testify to the fact that they are full of the desire to learn. And then... the shine in the eyes becomes dulled, and interest in study is extinguished.

What is the cause of such an abnormal situation? It is simplest of all to see it in the cadets themselves (they are bad) and in the problems of our whole society. It is namely that position that is taken by 75 percent of our pedagogues. The rest link the poor success rate of the students with their own gaps in knowledge, insufficient training and lack of the essential instructional skills.

Specialists occupied with this problem assert that the immediate causes of a loss of interest in studies at a military school are psychological discomfort caused by the overloading of programs of study, the poor quality of the UVP and alienation of the instructor from the trainee, and the use of instructional techniques aimed at memorization rather than the development of the thought and creative potential of the trainees.

The Russian pedagogue and psychologist P. Kepterov has written that "A dislike of difficult and little-understood school work is carried over into work in general, a dislike of work is cultivated and the conviction takes root, bit by bit and unnoticed, that the highest bliss is doing nothing, the absence of work." These words describe most fully the situation that has taken shape in today's UVP.

The military teachers also encounter a similar system of degradation of the personality—the cadet does not want to study, he is forced to, he studies by force and becomes a crammer and hates to study as a result.

Can the current situation be corrected? We see a way out first and foremost by relying on motivation. But a number of conditions must be realized for this under which interest in training arises and is developed in the future officer, and namely his involvement in the process of independent search for, and "discovery" of, new knowledge and the solution of tasks of a problematical nature, a diversity of class studies and the rejection of the monotonous feeding of information, a correct assessment of the work of the trainees, the mastery of the teacher and his faith in the students, reinforcement of confidence in each of them that he can handle difficulties etc.

Material and moral incentives that depend on the ultimate results of the work, including placement upon graduation from the school and advancement in the service, however, hold far from the least significance in the appearance of motivation toward studies among the cadets.

*Candidate of Technical Sciences Colonel V. Kaloshin and
Candidate of Technical Sciences Lieutenant-Colonel V.
Voronov (Kiev VVAIU)*

For a Sense of Time

The role played by the sense of time among birds is well known to specialists. But it is connected to more than the tasks of navigating and orientation in relation to the sun alone. The feathered creatures calculate their own energy, select the optimal frequency for beating their

wings to correct the range of daily flight and to replace the leader in the flock etc. depending on the wind speed.

There is a "temporal" mechanism in man as well. A refined sense of time is especially essential to the pilot. It is namely thanks to that that the pilot's attention is properly distributed in flight, devising a certain rate of movements of the controls (stick, yoke, pedals and engine controls) depending on the flight situation. The need for precise actions in time is especially important in takeoff and at landing, retraining on a new type of aircraft, maintaining the controls when pulling a winged craft out of a spin and the like.

Such qualities are acquired in the initial stage of flight training as the result of controlling the aircraft in conjunction with the instructor, as well as practicing in the simulator. The skills can also be perfected with the aid of simpler and generally available drills. For that it is enough to have... paper, a pencil and a stopwatch.

The essence of the initial stage of the simulations consists of the following. A pair of points is positioned an arbitrary distance from each other on a clean sheet of paper. They are then joined by straight lines over a strictly defined time. The precision of the performance of the drill is monitored with the aid of the stopwatch.

After the achievement of the necessary precision in maintaining the assigned time interval, the exercise is made more difficult—the segments of a straight line of differing lengths must now be completed over various time intervals that differ in duration. A further complication of the simulations is possible via the sketching of various graphical structures, as well as other exercises that are developed independently.

Having mastered these exercises, it is possible to learn to depict the required movements of the arms when controlling an aircraft with the aid of drawing lines. The most important thing is to raise their potential capabilities for improving flying skills.

A. Yannayev (Irkutsk)

Won't the Market Blow Out the "Spark?"

The aviation modeling club Iskra [Spark] has been operating in our city of Chernovtsy for more than twenty years now, and unites more than two hundred interested people of all ages and professions. We have made it our aim, among other things, to train the youth for service in the Air Forces before their call-up and to propagate the achievements of domestic aviation. The youth are interested in various circles and are constantly supplementing the collection, which now numbers about 1,500 models of aircraft, 4,000 *znachki* and 3,000 stamps on aviation topics. As a result one can note not only successful participation in six all-union and eighteen international competitions, exhibitions and contests, but also the martial prowess of the young people both as officers of the Air Forces and those who have entered flight and aviation-engineering schools.

It is of course gladdening that the good word about the clubs is proceeding across the whole republic. More could be achieved in this work, however, by including professional orientation and the selection and training of candidates for entry into the military high educational institutions, if we were supported by the officials of the local military commissariat and the Council of Defense Technical-Sports Associations. Their stance has earlier confused outside observers. Now, however, under conditions of a transition to market relations and ubiquitous scarcity, we have the right to count on help in an important national cause—the development of the aviation-engineering creativity of the youth. We are appealing to the journal, as constant readers of it who have not, by the way, let slip the opportunity to continue their subscriptions to 1992 as well. Perhaps our appearance will finally bring the attention of interested comrades to this problem?

V. Grechnev

Not by the Mind, but by Registration

Many are talking about the new thinking today. Not only political, I would note. Here in the army environment the times demand that we overcome the bad legacy of the past without delay. Judging by everything, however, the apparatus of the Ministry of Defense and the Air Forces Main Staff is in no hurry—or rather, is not able—to overcome the stagnation in all spheres of military organizational development. So then what about the realization of the concept of military reform?!

One of the causes of this situation, in my opinion, is the complete absence of a rotation of cadres in the system of administration of our armed forces. Having once been assigned to Moscow, the officer gradually loses his skills and lives according to the old standards, "fabricates" ever newer directives and recommendations, demonstrating his furious activity. There is no opportunity of replacing him in time with a young specialist with initiative—the living stock of the Ministry of Defense, not only in the capital, is today clearly inadequate, has a negative effect on the state of combat readiness and simply contradicts common sense.

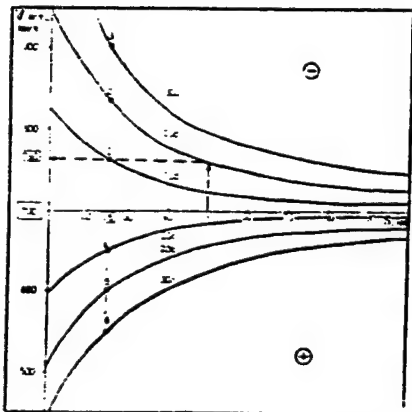
I am far from the idea that all of our misfortunes can be overcome all at once by willful resolution alone, but it seems sensible to me to allocate official apartments for the staffers of the military agency for the period of their service in the Moscow garrison.

Major O. Vladimirov (MVO [Moscow Military District])

Simply and Conveniently

Arrival at the target at a precisely designated time is the strict requirement posed toward flight crews when making a strike against ground targets. The conditions for waging contemporary battle are such, however, that rapid changes in the tactical situation frequently force the pilots in the air to alter the calculated parameters of the flight being performed.

Taking this circumstance into account, pilots preparing for each flight along a routing make calculations of the required true speed to correct possible deviations in the time of reaching the target (reference point [KO]) and compose them in the form of tables. This process, even though it is not labor-intensive, nonetheless takes up some time every time. The accomplishment of this task would be eased considerably by the use of a nomogram (see figure).



To construct it we first determine the flight time on a section of the routing, for example 25 kilometers, with a speed stipulated by the instructions or by decision of the commander for the sortie. Next, without altering the length of the section, we perform calculations for the cases of late and early arrival at the PPM (KO)—say, by 10, 20 and 30 seconds etc.—plotting the points 1, 2... 6 obtained on the graph. We later repeat the calculations, but now for route intervals of larger lengths.

It remains to combine the points obtained that correspond to the same time deviations by a smooth line. The nomogram is ready. Now in preparing for a flight the pilot only has to calculate the overflight times for all PPMs, and where necessary also the typical reference points before them.

For example, at the moment of overflight of the next PPM at a speed of 700 km/hr, the delay from the nominal time was 20 seconds. We determine according to the nomogram that we must maintain a speed of 760 km/hr to eliminate the error on the next stretch of the flight of 50 kilometers in length.

Pilot time errors in arriving at the target, as the practice in the utilization of similar nomograms in a fighter/bomber air unit showed, did not exceed an average of five seconds.

Military Pilot 1st Class Lieutenant-Colonel S. Makarenko, ZGV [Western Group of Forces]

...And a Shining Medal on the Chest

Our officer corps is frequently criticized for perpetuating state monopolies. The "iconostases"—bars with the ribbons of orders and medals on the chest of servicemen

that, in my opinion, do not look quite proper on the everyday uniform—are the subject of the attacks. It is not difficult to convince a dedicated person, after all, that the clutch of state prizes on a number of the medal bars of even the highest military commanders can be counted on the fingers of one hand. The rest testify either to some "glorious" anniversary or to friendship with former allies.

I hope that I am not diminishing our dignity if I propose changing the rules and stipulating that various insignia, anniversary medals and the like be worn only on the dress uniform jacket. Yes, they have been earned, but earned through labor—for which, by the way, they pay us money.

Major N. Starodymov (MVO)

Monument to a Hero

A letter from a reader of ours in Primorye, L. Ushchilovskiy, printed under the heading "The Names Recall the Heroes" (AVIATSIYA I KOSMONAVTIKA, 1991, No. 2) related the ordeals of the initiators to perpetuate the memory of the front-line pilot Hero of the Soviet Union V. Sirotn, buried in a local, half-neglected cemetery. Lev Vasilyevich recently sent us another letter, which we publish with pleasure.

I hurry to share a great joy—a monument has been placed on the grave of Hero of the Soviet Union V. Sirotn, and one of the streets in the military compound has been given his name. Twenty-two years of correspondence and visits to various offices have finally been crowned with success. The feature in your journal also helped. I did not expect that so many people from all corners of the country would respond to my letter. The money collected came in useful.

A museum of local history and economy was recently opened in the town of Khorol, where one of the exhibits is devoted to Sirotn.

And now we are restoring—rather, establishing—the place of burial of Colonel Karpov and Captain Vorobyev, who perished in August 1945 in the war with Japan. The remains of the pilots were sent from Manchuria to their native land and interred in their places. Some riff-raff, however, have destroyed the modest obelisks. But we are obligated to find the graves of the fliers, and with time we will put monuments there. The memory of the heroic fliers should live!

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Effects of Schedule, Fatigue on Airfield Vehicle Drivers Studied

92UM0898E Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 91 (signed to press 17 Dec 91) pp 10-11

[Article by Major A. Gabrielyan under the rubric "The Rear and Flight Safety": "The Range of Reliability"]

[Text] *The significance held by raising the professional reliability of the drivers supporting the ground concerns of aviation units is well known. Here is how to determine the high end results of their work, what the specific features of it are, what we think about too rarely. We hope that the conclusions of a military medical person on this issue will be of interest to the corresponding officials, and that they will take it into account.*

Comprehensive psycho-physiological research has been conducted in order to assess the effects of the specific features of the professional activity and regimens of work and rest on the functional state of the organism of drivers of specialized vehicles. The drivers of the specialized vehicles of an airfield maintenance company (AER), whose work is characterized by high tension, were involved in the research. The drivers were observed after three, six and nine hours of work in order to study the specific features of changes in the functional state of the organism.

The following indicators were studied: the lability of the central link of the visual analyzer, simple sensomotor reaction to a sound stimulus, shaking of the fingers of the hand, functional mobility of the motor analyzer (according to the tapping-test technique), the values of the maximum muscular effort and the static muscular endurance. The reaction to a moving object was also evaluated, and the arterial pressure and frequency of heart contractions were measured.

A study of the questionnaires and a poll of the subjects revealed the following factors of the working environment, in order of importance, that have a negative effect on the ability to work: the level of pollution of the air, intensive noise, low temperatures, vibrations, insufficient ventilation and air drafts.

Frequent disruptions of the work and rest regimens also had a substantial effect on the ability of the drivers to work. Time and motion studies made it possible to establish that the duration of flight-support operations totals from four to ten hours a day, and depends both on the nature of the work (the type of vehicle) and the specific weather situation. The drivers of the AER, according to the estimates of the command personnel, are forced to work at the limits of their capabilities in heavy weather conditions. The duration of rest (uninterrupted nighttime sleep) frequently totals just three hours for a span of three or four days in a row in the winter.

The abnormal working day of these specialists leads to the fact that a large portion of their working time goes for preparatory and concluding work, as well as coming to and going from the airfield, including maintenance, repairs operations and interruptions to eat. This takes from 4.5 to 14 hours a day overall. The duration of the nighttime rest for the drivers during the winter period of combat-training activity usually fluctuates from six to eight hours, and in the summer lasts seven or eight hours.

This is, as they say, the consequence. The principal causes of the considerable duration of the drivers' work are the undermanning of the subunits with personnel and the large expenditures of time for the repair of equipment (sometimes due to the failure to fulfill the requirements of the standard documents for the servicing of specialized motor transport). Drawbacks in the organization of their labor also have an effect—the workplaces for the repair of the equipment are equipped in primitive fashion, heating and ventilation systems are lacking, as are small-scale mechanization equipment, while work tools are in short supply.

An analysis of the results of the investigation with the aid of the SAN test, describing changes in neuropsychic status, revealed the following. Pronounced functional shifts were noted primarily in the winter, that is, during the period of the most intensive operations. A reduction in the indicators of the functional state of the organism was noted as early as three hours after the start of the shift—32.9 percent for the drivers of the V-68 air-blowing machinery, and 10.3 percent for those of the TM-59 heating vehicle. They were distributed as follows after nine hours of work: 36 percent for the drivers of the TM-59 vehicles, 39 for the V-68, 9.8 for the KPM-3M (a combined hosing and washing vehicle) and 2.2 percent for the R-452 (a rotor-screw vehicle). These changes testify to the fatigue of the drivers caused by nervous emotional stress.

The drivers of the specialized vehicles begin to feel tired starting from the third hour of uninterrupted work at the airfield, and sluggishness, irritability and enhanced weariness are noted in them. Research of simple sensomotor reaction to a sound stimulus led to the conclusion that statistically significant differences in relation to the background data were manifested after the expiration of the same period of time and increase significantly by the end of the work day, especially for the drivers of the KPM-3M (by 28 percent). These changes testify to the presence of a pronounced fatiguing of the organism.

The corresponding research was conducted to ascertain the dependence of the psycho-physiological reliability of the driver personnel on the state of the motor apparatus with the aid of the tapping-test technique. It was established that the indicators of shaking and static muscular endurance underwent the greatest changes.

It was determined in studying the critical frequency of the merging of light flashes that a reduction in lability of the visual analyzer was observed in drivers as early as after three hours of work (by 12.3 percent in summer and 1.1 percent in winter for the KPM-3M, 8.1 and 5.8 respectively for the V-68, 5.7 for the TM-59 and 8.4 percent in winter for the R-452 compared to the background data). The more strained work of the visual analyzer of the KPM-3M and V-68 drivers was conditioned by the fact that those two groups of drivers are the principal ones in the preparation of the airfield in the summertime. Later, after nine hours of work, the functional state of the subjects worsened significantly—

fatigue increased and ability to work decreased. This is very important to note, since the drivers of those vehicles perform visual monitoring of the results of their activity.

Comparative analysis revealed that the reaction to a moving object, indirectly characterizing an increase in erroneous actions, displayed a significant tendency to change. Larger negative shifts were typically noted in the drivers of the indicated vehicles during the winter than in the summer, with the exception of the KPM-3M, for which the nature of the changes effectively did not depend on the time of year. This is probably due to the involvement of the KPM-3M drivers (especially in the summer) in housekeeping chores on the grounds of the garrisons.

Changes in the functional state that could be defined as a pronounced fatiguing after nine hours of work are thus observed in the drivers of specialized vehicles of the AER under the effects of a whole set of unfavorable factors on the body, which could have a substantial effect to an equal extent on both flight safety and on road traffic.

The research thus established that the professional activity of the drivers often takes place against a background of incomplete restoration of functional shifts in the body as a consequence of limited—less than seven hours—rest (sleep).

A shift-by-shift schedule of work should be instituted in order to avert fatigue among the drivers of specialized motor vehicles. This question could also be resolved through the timely replacement of the equipment that has used up its stipulated service life and its constant renewal. The building of special repair bays equipped with systems for the creation of the optimal microclimate and small-scale mechanization equipment would also facilitate an improvement in the working conditions of the personnel.

It is essential to strengthen the periodic monitoring within the framework of medical observations, and to strive for the fulfillment of the requirements of the documents regulating the procedure for the performance of pre-run inspections of the drivers of the motor vehicles, in order to preserve the high level of working ability of the AER drivers. No small importance is also assigned to the role of measures aimed at restoring the functional state of the drivers (sleep of no less than eight hours a day, special physical exercises, contrast showers and massages, among others).

The realization of these and other measures to regulate the work and rest of the drivers of AERs will facilitate the rapid restoration of their working ability and a rise in the effectiveness of the activity of this category of aviation specialist.

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Organizational Drawbacks in Airfield Technical Support

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[Article by Lieutenant-Colonel V. Melnikov under the rubric "Combat Training—The Problems of the IAS [Aviation Engineering Service]": "The System Needs Correcting"]

[Text] The article "To the Foundation, What For?" by Captain V. Mayorov set forth quite accurately, in my opinion, the drawbacks of the new standard organizational structure (OShS) that, by the way, is not operating at full force. The replies of specialists to the editorial "The System Needs a System" (AVIATSIYA I KOSMONAVTIKA, 1990, No. 10) by and large confirm the ideas of the author. I agree with Colonel N. Rozhkov that the OShS, as before, does not take into account the reality of life in the aviation units—the necessity of filling out various types of graphic and reporting documentation, the performance of housekeeping chores, serving on details and the like, constantly causing the separation of a considerable portion of the specialists from the performance of their functional duties.

I would like to remind Lieutenant-Colonel S. Bocharov that the technical matériel in ATO [airfield technical support] remains, as before, at the same quantity as figured for the servicing groups as well. It is thus difficult to understand how it will be possible to assemble an autonomous team. The situation is the same with the personnel—in reality not one of the crews has the full complement of specialists (not to mention warrant officers). The crews for working at the forward airfields are thus staffed in the old manner.

The shortage of personnel has also brought about permission to include the engineers of ATO by fields in the complement of the technical crews, and a mechanic for the aircraft and the engine (routing No. 2) services two aircraft, which could be regarded as a step backward. It would be expedient to discuss the following proposals in this regard:

- to institute the standard position of one officer/specialist in place of two warrant officers (on the crews, on the groups for servicing and maintenance, in the regimental groups) for units stationed in those regions of the country where the recruiting of warrant officers is virtually impossible;
- to return to the old OShS, leaving the captains' positions to the chiefs of the flight TECh and chiefs of the servicing groups, without changing some of the positive elements of the new OShS; the accounting and planning division, the standard group for the interpretation and analysis of the accuracy characteristics of weapons delivery etc.

Or this version: organize subunits that consist entirely of specialists in one field, with the commander of the subunit the former senior engineer of the unit for that field; the engineer, after all, effectively supervises the specialists in their everyday activity "through the head" of the commanders of the ATO and the crew chiefs.

It is also essential to introduce into the standard organization assistant senior engineers of the units by fields or simply engineers, since in the absence of the former (leave, illness) there is no full-fledged replacement for them.

Think out and institute insignia of distinction for the technical uniform. That, in my opinion, would have a positive effect on the specialists of the IAS [Aviation Engineering Service].

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Two Views on Causes of Takeoff Accidents, Their Prevention

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[Articles by USSR Ministry of Defense SBP [Flight Safety Service] First Deputy Chief Major-General Aviation A. Osipenko and Military Pilot 1st Class Colonel V. Goncharov under the rubric "Flight Safety: Two Views of the Problem"]

[Text]

Analyzing the Flight Accident...

The good weather on that day and the fighting mood of the fliers inspired confidence among the unit command in the successful performance of the flight shift.

Weather reconnaissance in a dual trainer had been performed by experienced pilots. Seemingly nothing presaged any misfortune. But in the forty-third second of flight the aircraft collided with the ground, and the crew was killed.

The rapidity of the development of the situation and the absence of reports from the pilots made the work of the flight-accident investigatory commission more difficult. They had to check out several versions of the possible reason for the crash. What did the commission establish?

The results of the research showed that the aircraft was in good working order and the pilots were able to work. According to data from the objective monitoring equipment, the crew commander permitted a significant increase in the angle of attack in the takeoff after liftoff, as a consequence of which left roll appeared in the fortieth second and the normal G-forces began to increase. The gain of altitude halted at 30-40 meters and a speed of 320 km/hr. The angle of roll later increased to 63° and the G-forces reached 2.2, while the angle of attack exceeded the critical, which led to the stalling of

the aircraft. The maneuver of the aircraft corresponded entirely to the setting of the control surfaces.

The conclusion of the commission members was unequivocal—an error had been made in piloting technique that led to the appearance of a difficult situation. The crew did not make use of means of escape. Other links in the aviation system were not actuated, either. The flight operations officer, in front of whose eyes the events transpired, did not give a command to reduce the angle of attack and pull out of the roll, and later to eject.

Whether this outcome is accidental or not, we will leave the right to resolve it to the commission and will continue the discussion of the organization of flights.

Two flight accidents had occurred in landings on the same flight shift in the same unit the day before the crash—an accident and a breakdown. The cause in the first instance was the unsatisfactory supervision of the flights. Many supervisors of various ranks in the unit were replaced after that. A barrier would seem to have been placed in the way of violations. But matters in fact turned out otherwise. An untrained officer was permitted to supervise the flights for aerial weather reconnaissance. And he did not issue the proper command.

The crew commander had made 32 such flights that year, and gross violations of the procedure for performing the flight assignment and mistakes in piloting technique had been committed on 29 of them. They had a "tradition" in the unit—they took into account only the precursors to flight accidents [PLP] that were committed by cadets.

It is necessary to talk in particular about the completeness of the accounting. Some 13 dangerous PLPs were revealed by the data of the objective monitoring equipment alone, connected with reaching critical angles of attack, exceeding G-forces and angle of roll and decreasing to below stipulated altitudes. Six of these were committed by instructor pilots. More than 20 PLPs were revealed in the organization of flights—they including exceeding the loads, piloting and landing at dusk by pilots not trained for night flight, the absence of a plan for the performance of aerial weather reconnaissance and flights according to a flight operations schedule not approved by the commander. A liftoff speed 30 km/hr less than that stipulated by the Manual for the Flight Operation of Aircraft was noted in 99 percent of the cases in the logs of the inflight monitoring of the actions of the flight personnel. All of what occurred was unfortunately not noted by the senior officers.

And how is one to explain the fact that not a single training session was held in the squadron over all of 1991 on aircraft stability and controllability at low speeds? And was it not for that reason that all of the officer/pilots of this subunit received unsatisfactory evaluations in this area in knowledge tests? I admit that I experienced a feeling of shame when a cadet was setting forth the material in their presence. The justification of the officers was not particularly apt—the cadet should know

better, they said, since we are working on him... The practice of holding training sessions in aerodynamics only by the instructional staff has also taken root in the unit.

The causes of this flight accident were gross errors by the crew in flying technique at the takeoff, the late issue of a command from the flight operations officer to assist the pilots in the difficult situation and drawbacks in the organization, performance and support of flights as expressed in the lack of monitoring of the completeness and quality of the performance of flight assignments and the observance of safety measures by the supervisory flight personnel.

A 'Difficult Situation' at Takeoff

When analyzing flight accidents and the precursors to them that occurred as a consequence of the curtailment of takeoff or the demolishing of the aircraft at low speed, it is essential to take into account not only the incompetent actions of the pilot with the control surfaces and the poorly practiced procedure for the distribution of attention, but also the psychological aspect of the professional activity of the pilot as well.

For that purpose we will trace the changes in the psychological state of the pilot in two concrete situations at takeoff, depending of the position of the point on the runway of the separation of the aircraft from the ground.

If the place of liftoff of the craft is located a considerable distance from the end of the runway, the pilot has no doubt of the performance of a normal takeoff or of stopping within its limits when curtailing the takeoff run—in the event of engine failure, for example. The pilot, that is, monitors the situation and controls the aircraft in accordance with it.

It is another matter if the craft for some reason (high air temperature, heavy weight and the like) makes a longer than usual run or the liftoff point is 200-300 meters from the end of the runway. In that case the pilot observes the rapidly approaching edge of the runway and, in certain cases, doubt could begin to dominate in him of the possibility of taking off within its limits. Why does this happen from the point of view of aviation psychology?

We will recall as a start that the operative image of the flight is a mental conception of its position and movement in space at a given moment in time, which takes shape on the basis of the readings of instruments and non-instrumental information and with a regard for available knowledge and experience in flight operations. The sense of time is inseparable from that image and has a substantial impact on the behavior of the pilot in flying.

If doubt arises in him of the possibility of a normal takeoff, then as a consequence a discrepancy in the perception of the information coming from various sources could ensue: visual—the rapidly approaching end of the runway and the slowly increasing speed;

aural—the unusual noise of the operating engines; and, tactile—the thrust of the power plant drops, the acceleration is too small.

As a result the reflex to the time and position of the aircraft on the runway that has been devised in flights "demands" either that the takeoff be halted or that the liftoff of the aircraft begin, although the pilot may be aware that the speed may be insufficient.

A so-called "difficult situation" thus arises that is able to lead to the making of an erroneous decision. And the less prepared the pilot is in a psychological regard to perform the takeoff under extreme, unusual conditions, the greater the likelihood of the appearance of this situation.

The simplest and most effective method of averting such instances of undesirable consequences is ideomotor simulation in the cockpit before the flight. The repeated rethinking of the impending situation in the mental depiction of the location of the aircraft at various moments in time ensures the psychological readiness of the pilot for the upcoming flight assignment. The effect will be all the greater, the better developed is his imagination and ability to visualize the situation.

Experienced pilots usually possess such qualities. They are also not overly protected against unpleasant random occurrences, however, especially if they neglect cockpit simulations.

It is more difficult for those who are young and inexperienced, do not yet possess solid flight skills and are less prepared in a psychological regard. Simulations in the cockpit on the runway will play a large role for them along with "flights" in the simulator—the pilot sees the position of the end of the runway and memorizes it in a normal situation from the place of liftoff of the aircraft. It is not only not difficult to organize this, but is also simply essential before the first flights with large takeoff weights, at airfields in mountainous areas or at shortened sites.

Control of an aircraft is a crucial and complex type of human activity, and an awareness of the depth of danger of the phenomena, simulations and any other opportunity that facilitates the adaptation of the pilot to this process should be realized by them themselves, the instructor and the aviation commander. I see in this the essence of the prevention of flight accidents that are the fault of the pilot.

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A-50 Long-Range Radar Detection Aircraft Profiled

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[Article by Candidate of Technical Sciences Lieutenant Colonel P. Ivanov under the rubric "Domestic Aircraft": "The A-50—A Winged Patrol"]

[Text] *Bewilderment and delight arise simultaneously in all who see this aircraft for the first time—its mushroom-shaped radome over the mighty fuselage makes it so unusual and grandiose. The word AWACS involuntarily comes to the mind of people who are somewhat well-informed. The long-range radar-detection (DRLO) aircraft really are usually associated among non-specialists with aircraft of the E-3A AWACS type of the U.S. Air Force. And only a few know that the skies were being ploughed by nine Tu-126 radar patrol aircraft with the Liana electronic system long before the appearance of the E-3A.*

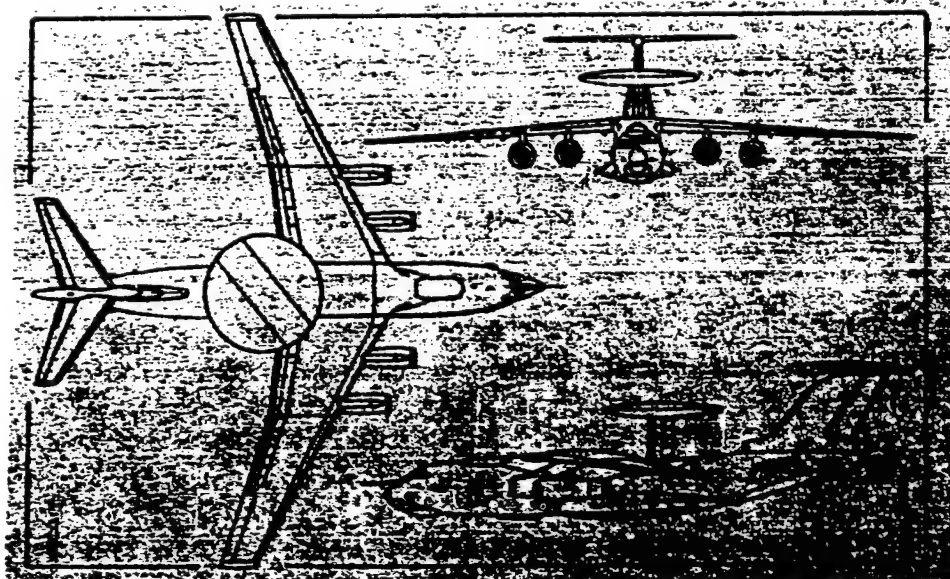
The Tu-126 of course possessed far from all of the capabilities of the modern E-3A, but was rather intended only for the early radar detection of aircraft over the sea and submarines and determining their national affiliations. The transmission of data on the targets detected to air-defense command posts was accomplished through special radio-receiving stations. The Tu-126 was in essence none other than a flying radar that was not able to detect targets against the backdrop of the ground. These and other drawbacks were the basis for the actual curtailment of programs to create domestic DRLO aircraft systems in the 1960s.

The E-3A AWACS early-warning radar system—the first production model of which the firm of Boeing was offering to transfer to the customer the following year—had meanwhile already been demonstrated under conditions close to a real environment in the summer of 1976 at the test range of Nellis Air Force Base. The “real environment” was created in a big way: six aircraft imitating MiG-23s “attacked” the E-3A, two of which were accompanied by jamming aircraft simulating the Yak-28PP. Four ground jamming stations and two ground-based interceptor guidance radars were also “operating” against the E-3A. It was given two F-15s, four F-4s and one F-105 to wage its “combat operations”

(the latter to guide a strike against the ground jamming stations), along with two aircraft on station to jam the ground-based interceptor guidance radars. The ability of the E-3A AWACS to perform its functions successfully under conditions of “enemy” opposition and guide its own fighters to the targets as a means of self-defense was demonstrated as a result.

It was emphasized at the U.S. Air Force symposium “Tactical Aerial Warfare: Present and Future” in 1978 that further improvement of the E-3A aircraft was one of the most important programs for raising the combat might of aviation. This was confirmed in the course of the combat operations in the Persian Gulf region. Some 24 E-3A aircraft (eight belonging to the U.S. Air Force, eleven to NATO and five to Saudi Arabia) successfully performed three principal tasks—controlling tactical aviation in carrying out group and individual strikes against ground targets, supporting the link-up of strategic aircraft with tankers and specifying target coordinates for them, and monitoring the airspace and controlling the opposition of enemy aircraft.

The shortsightedness of the decision made in the USSR in the 1960s to freeze for a decade the programs to create DRLO aircraft is obvious. It should be said for the sake of fairness that scientific-research work on the creation of the basic elements, problems of processing radar information, determination of the reflective properties of the Earth’s surface and the like was being conducted in our country in those years at the initiative of the Air Forces, even in the face of limited financing. When common sense prevailed in the minds of the “powers that be,” it thus proved possible to create a long-range radar-detection and guidance aircraft—the A-50—in a relatively short period of time. The development of the A-50, as in the creation of virtually all prototypes of complex technical systems for military purposes, proved to have a revolutionary effect on the development of domestic science and practice.



The series-produced Il-76, selected as the basis for creating the A-50, was substantially refined in the area of accommodating the radar antenna with a ten-meter (in diameter) radome rotating in flight, along with other antennas, and the creation of systems for electric-power supply, cooling of the gear and accommodating the crew and their life and functional support.

What are the combat capabilities of the A-50? They are the long-range radar detection of airborne and naval targets, including airborne targets at very low altitudes, over terrain with any relief; determination of the national affiliation of the targets; transmission of information to the ASU [automatic command and control system] on the trajectory of their movement; and, the guidance of the aircraft at the disposal of the Air Forces, Air Defense and the Navy to targets and to aerial refueling, among others.

The A-50 is equipped for those purposes with a high-coherence pulse-Doppler radar with large illumination capacity, equipment for the digital processing of the radar information, recognition and control of fighters, radio communications with aircraft and ground ASUs, including a satellite network, the monitoring and documenting of information, workstations for the crew members with a system for depicting information, a computer system for information processing and control of the operation of all on-board apparatus, and a high-precision piloting and navigational system as an aggregate of interconnected inertial, aerometric, electronic and computer devices.

The A-50, in the words of one of the inspectors from the Air Forces Main Staff, is a modern means of raising the combat effectiveness of aviation through the creation of a continuous radar field and the achievement of maximum continuity and automation of the processes of command and control in the course of performing the basic tasks by aircraft crews in various branches of aviation.

It remains, of course, to undertake no small effort to obtain the full impact of the capabilities inherent in the A-50, but even a simple listing of the tasks it performs and the composition of its systems is sufficient to see that the A-50 is far more than just a flying radar station like the Tu-126. It must be said in honor of domestic industry that no one else has proved able to create an aircraft that performs the same missions as the E-3A AWACS. The British Air Force, for example, having spent about a billion pounds, was forced to drop the development of its own DRLO aircraft and order seven of the E-3A type aircraft from the United States in 1986-87.

But time does not wait, and functional obsolescence is unfortunately not far off for the A-50. The Stealth technology and the prospects for the creation of DRLO aircraft abroad, for example, "promise" that. It should be noted that the E-3A AWACS is not the sole DRLO

aircraft in service there. The use of E-2C Hawkeye aircraft is planned along with it until the year 2010, for example.

It is noteworthy that the use of the mushroom-shaped radomes over the fuselage is not now envisaged for some of the next generation of DRLO aircraft being intensively developed abroad; the new radars will be equipped with contoured antenna arrays built into the structure of the fuselage and aerodynamic surfaces of the aircraft.

The following cannot fail to be noted as pertains to the further prospects for the use of today's AWACS aircraft. The U.S. Air Force command, according to a Reuters report, is forming up an entirely new formation for carrying out air strikes, proceeding from the lessons of the war in the Persian Gulf. Its first air wing, including F-15 fighters, F-16 fighter-bombers, seven B-52 bombers with OSP [instrument-landing equipment], AWACS aircraft and tankers is already stationed at the (Manuti-Hom) Air Base. Logic suggests that the forces to counter such a "rapid intervention air wing" cannot fail to have DRLO aircraft in their composition under any nature of military doctrine. But that is an assumption of the author.

The necessity and possibility of using DRLO aircraft for the realization of the principle of "open skies" and the control of air traffic in difficult-to-access regions, or in the event an emergency situation should arise (earthquakes, floods and the like), are obvious, in the opinion of the chief designer of the A-50's on-board equipment systems.

It is important, in the face of cutbacks in defense spending, not to lose pace in solving scientific problems. Apropos of DRLO aircraft this is, first of all, increasing the range of detection of small targets under jamming conditions.

All of this does not require all that much for its existence—do not let a matter that was set up with difficulty die away. It still remains to guess in how many years we will be able to return in earnest to the development of DRLO aircraft of this class—in ten years, as after the Tu-126, or sooner—and whether such people as were able to create the A-50 in a short time will be in our industry.

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Desert Storm Antiradar Tactics, Stealth Drawbacks Critiqued

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[Article by Candidate of Military Sciences under the rubric "Aviation in Local Conflicts": "In Search of New Tactics"; conclusion—for beginning see Nos. 9-11]

[Text] (According to materials in the foreign press)

4. On the Trail of New Hardware

Over the course of the entire history of the development of aviation, the tactics for waging combat operations with it have been perfected to the extent of the creation of new models of hardware and weaponry and the constant rise in the level of training of the flight personnel.

This was confirmed in the course of the war in the Persian Gulf as well. The aviation hardware utilized there has grown significantly since the end of the war in Vietnam, which reflects the increased complication of the missions performed by aviation: aerial battles were now waged by F-15C aircraft, whose maneuvering characteristics and armaments made it possible to attack and destroy an airborne enemy at any range; direct support for the troops was performed by attack aircraft that were "resurrected from the ashes"; all-weather fighter-bombers were freed from participating in combat operations over the battlefield, and performed only specific missions (attacks against airfields, participation in the breakthrough of air defenses, disruption of lines of communication, the battle against reserves and the destruction of important targets at operational depth).

The crews of the fighters (the American F-15C, French Mirage 2000 and Canadian CF-18) also typically performed cover for the strike forces of MNF aviation, despite the absence of any serious opposition whatsoever on the part of Iraqi fighters, and were not involved in the performance of other missions. They just perfected their performance of escort of strike groups and the organization of interaction with the bombers, EW aircraft and VKP-DRLO [airborne command post/long-range radar-detection] systems.

Foreign military experts include such unswerving observance of the conformity of the functions entrusted to the crews of the aircraft or helicopters to the capabilities of the aviation hardware as one of the factors facilitating the high effectiveness of the combat operations of aviation.

The changes in tactics were most visibly reflected in the method of winning air supremacy. Such a traditional method of achieving that task as the destruction of enemy aircraft on the ground was replaced by a new one in the U.S. Air Force regulation documents after the October War of 1973 in the Near East—the disabling of the runways of airfields (due to the fact that after the Six-Day War of 1967 reinforced-concrete shelters began to be built for the aircraft).

The crews of the British Tornado GR.1 fighter-bombers thus carried out the drop of 30 SC357 anti-concrete submunitions and 215 smaller-sized HB876 mines from a JP233 scatter-bomb container hung from the fuselage during the course of combat operations in the Persian Gulf when making strikes against runways. The crews were forced to make a tight pass over the target at an altitude of 50-150 meters before opening the container, which inevitably led to the entry of the aircraft into the

field of intensive fire from the anti-aircraft artillery covering the airfield. It was thus no accident that the Tornado fighter-bombers performing this mission suffered greater losses (seven of the craft were shot down in all) than aircraft for any other purpose.

Despite the fact that the use of the latest weaponry made it possible to cut in half the detail that used to be considered optimal for the disabling of runways, the stereotypical nature of action in the delivery of the strikes in this case had a negative effect on the survivability of the aircraft. Foreign experts include such disruptions of the equilibrium in the "hardware—tactics" system as one of the main lessons of the conflict.

The next method of winning air supremacy is the fire suppression of enemy air-defense assets. Supremacy should be achieved, according to the views of the U.S. Air Force command, through decisive offensive actions by aviation and the simultaneous destruction of air-defense assets that are revealed until their threat is eliminated entirely or is at least reduced to the level of acceptable risk. Actions using the "blinding—suppression" method are considered to be the principal tactical variation therein—a continuous search is made for detection (guidance) radar that is part of the air-defense system, its "neutralization" with active jamming and then its destruction using antiradar missiles (PRR) with self-homing to the source of the emissions.

Tornado aircraft used the new ALARM type PRRs in the very first days of the Desert Storm operation, which made appreciable changes in the tactics of breakthrough. The unresolved problems in it in the past were connected first and foremost with the increased vulnerability of the aircraft carrying the PRR, which was forced to enter the lethal zone of the SAM systems being attacked at the moment of launch. The homing head (GSN) of the ALARM PRR has a wideband receiver, as well as a digital processor, able to process incoming signals and select the priority target. The high-explosive fragmentation warhead of the missile is detonated by a proximity fuze at an altitude of about four meters above the radar being attacked.

Two basic methods of employing the ALARM missile are programmed in before the sortie. In the first case the aircraft carrying the missile executes the flight without crossing the outer boundary of the SAM lethal area. The pilot or weapons officer, having received a signal of the illumination of the aircraft, launched the missile, which then independently (according to the program) climbed to an assigned altitude and went into horizontal flight in the direction of the target. In search mode the radar signals received by the homing head are compared with reference signals of standard radars. The homing process of the PRR began after the lock-on to the target.

If the lock-on was broken, the missile gained altitude on the order of 12 km in accordance with the program, after which its engine was cut and a parachute was deployed. During the descent of the missile the homing head

conducted a search for signals from emitting radars, and after lock-on the parachute was jettisoned and the missile glided onto the target.

In the second method the missile GSN would receive target designation from on-board gear and was locked onto a target selected by the crew. Only after that were the launch and guidance of the missile executed (the traditional method employed by the crews of aircraft carrying guided-missile weaponry when interacting with EW aircraft).

About 300 launches of ALARM type PRRs were made during the course of the Desert Storm operation, and 80 percent of the targets under attack were hit.

Foreign specialists link the most appreciable changes in the third method of winning air superiority—undermining the military-economic potential of the enemy and destroying important targets deep in the rear of his territory—with the combat application of the F-117A Stealth aircraft.

Two squadrons of these craft made 1,100 sorties over the whole period of the war with Iraq, primarily at night. The principal ordnance they used was 900-kg guided aerial bombs (GBU-10 and GBU-27) with laser homing.

The small radar signature (about 0.01 m²) assured the "invisible aircraft" flight with impunity in the zone monitored by medium-range SAM radars. The problem of ensuring the invulnerability of these aircraft was solved, as testified by the results of the conflict—the F-117A squadrons did not suffer any losses. U.S. President Bush, speaking at an aviation college, called that aircraft "an outstanding achievement that opens up broad prospects." Drawbacks that were revealed in the Stealth concept, however, are concealed against the background of enthusiastic comments about the F-117A.

First of all, means of support were operating intensively for the new aircraft: medium-range air-defense systems were neutralized ahead of time by the fire of "break-through" subunits, and only after that did the Stealth aircraft enter the "swept" corridor. Caution clearly took the upper hand over the desire to submit the new aircraft to verification in an environment of "real threats."

One of the F-117A pilots declared that they were forbidden to descend below 20,000 feet (6,300 meters) during the course of attacking ground targets. The crossing of that line signified entering the lethal zone of the low-altitude SAM systems with optical detection and aiming systems. The impact of the Stealth aircraft was thus felt only at medium and high altitudes.

Second, the pilots of the F-117As were acutely in need of target designation from an external "source" (due to the lack of an on-board radar). The VPK-DRLO system, however, was not able to track the Stealth aircraft and warn their crews of threatened hazards or control them in the course of making strikes against the assigned targets.

Third, the maximum bomb load of the F-117A aircraft is too small by modern standards—just two laser guided

bombs, whose use is designed only for good weather conditions. Clouds, thick smoke, heavy dust in the air or infrared emissions from fires proved to be a serious impediment in bombing. The Stealth aircraft were thus forced to stay on the ground in bad weather conditions, and their missions were performed by fighter-bombers.

Fourth, groups of F-117A aircraft operated independently in mass raids, as a rule. A zone of up to 160 km in radius was freed up for them, within the confines of which the pilots make unrestricted maneuvers and perform aiming with the aid of night-vision systems without fearing collisions with other aircraft. Two versions of the operations were practiced—the first was entirely autonomous, and the second had the support of jamming accomplished by EF-111 EW aircraft stationed at the perimeter of the operational zone of the Stealth aircraft.

Fifth, one F-117A aircraft cost no more or less than 46.2 million dollars, that is, almost twice as much a fighter-bomber. The "selective" invulnerability achieved through the imposition of altitude restrictions on combat application, flight speeds (the aircraft is subsonic), bomb loads and the accomplishment of interaction with other elements of the operational structure of the air forces taking part in the operation thus also had a high cost (it is appropriate to recall here that the EF-111 EW aircraft costs 73.9 million dollars).

And, finally, the pilots of the F-117A aircraft, forced to operate independently, experienced great physical stress in flight—the lack of information on the external situation forced them to avoid even the slightest deviations from the projected plan and to observe strictly the assigned flight mode (the reaching of the planned lines and patrol zones was accomplished with a precision of up to three seconds, and deviations in the flight altitude did not exceed a few dozen meters at all stages of the flight). No less strict requirements were also posed toward the precision of aiming and maneuvering. Gains in effectiveness were achieved, as we see, at the expense of exhausting the pilots.

The principal reason for the crashes of F-117A aircraft in 1986-87, according to a report by the Associated Press, was crew fatigue—the physical and mental stress on the pilots reached the limit (their workday was 12-14 hours, allowing for pre-flight preparation). The crews, as investigation of these accidents showed, did not even make any attempts to abandon the aircraft in emergency situations.

The incorporation of automation in the process of pre-flight preparation for the purpose of easing the development of the combat flight plan is considered a no less important problem. Its use also made it possible to model the tactical situation in the course of the operation with a regard for reconnaissance data coming in on the grouping of enemy air defenses, and to reproduce the necessary information on the indicator of the FLIR on-board forward-scan television system of the F-117A in real time.

The development of standard tactical devices was also included in the process of ground preparations of these aircraft. A pair of Stealth aircraft, for example, entered the target zone at an altitude of 6,000-7,000 meters in a battle formation closed in front and rear. The search for the strike targets was accomplished with the aid of an on-board television system. The pilot who detected the target first transmitted the information along a closed communications channel and structured the nominal (also standard) maneuver to approach the target with a regard for the location of the loiter zones of the EW aircraft. The command to release the guided aerial bombs was issued by an on-board computer with steady laser "illumination" of the target, after which the attacker could execute a breakaway on a return course. The process of "illuminating" the target (it could also be accomplished by the wingman) was not interrupted therein, which ensured the homing of the UAB ("flight in a cone").

It has been noted by specialists that group and solo strikes using guided ordnance are not distinguished by any particular tactical diversity. The restrictions imposed on the spread of the parameters of the pass, the combat maneuver and the trajectory of the attack were conditioned by the complexity of the homing process (laser, television and thermovision) of the ordnance. A definite tactical stereotype, however, significantly eased the automation of the principal type of combat flight. A provision written into the Manual of the Combat Application of Tactical Aviation of the U.S. Air Force is of interest in this regard—"Complete standardization under combat conditions could lead to serious problems, since the enemy will undoubtedly uncover the intent of our actions. In a complex aerial environment, however, standardization has become permissible within reasonable limits. Experience has shown that tactical flexibility is not diminished therein, thanks to the rapid and controlled reaction to threats that arise."

What are the prospects for the development of tactics for the employment of aviation hardware and armaments? The answer is obvious: human society has entered an era of high technology, which will lead to the constant review and improvement of views that had taken hold previously. The dialectical confrontation of the sword and the shield that goes back centuries will therefore continue into the foreseeable future as well.

From the editors. *This article concludes our publication of the series of materials "In Search of New Tactics," in which the history of the search for the effective application*

of aviation in military conflicts has been considered. But we will not stop here. The editors intend to continue coverage of this topic.

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WWII Air Support for Moscow Defense, Counter-Offensive Recounted

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[Article by Candidate of Military Sciences Major-General Aviation (Retired) L. Shishov under the rubric "The 50th Anniversary of the Most Important Events of the Great Patriotic War": "Soviet Aviation in the Battle of Moscow"; conclusion. For beginning see No. 11]

[Text] By December of 1941 the Air Forces of the Red Army had not only righted themselves after the heavy losses that had been suffered in the first months of the war, but had also been able to win air supremacy in bitter battle with the aviation groups of the Luftwaffe aimed at Moscow.

It should be noted that the Hitlerite command, in assessing the state of Soviet aviation at the time, made a substantial error that later became one of the reasons for the defeat of the fascist troops around Moscow. They assumed, relying on reconnaissance data, that the Russians had just 210 aircraft against the 410 German aircraft operating in support of Army Group Center. In December, therefore, a portion of the forces of the 2nd Air Fleet (6-7 Air Groups of the 2nd Air Corps) was transferred to southern Italy and Sicily. The administration of the fleet was also sent there, and its functions on the Soviet-German front were transferred to the headquarters of the 8th Air Corps.

The supreme command of the Wehrmacht and the Luftwaffe, convinced of the superiority of their aviation, evidently felt that the Soviet Air Forces in the Moscow sector would not be able to have a serious impact on the course of the combat operations due to their small numbers and low battleworthiness.

The Air Forces of our Western Front really did have about 200 aircraft by the end of the defensive period. Mobilizing all reserves, however, the Soviet command was able to concentrate a large air group in a decisive strategic sector over a short period of time and achieve a substantial advantage in air forces, as can be seen from Table 1.

Table 1—Composition and Correlation of Forces of Aviation by 6 Dec 41

Branch of aviation	Soviet Air Forces	German aviation	Correlation of forces
Fighters	550	160	3.4:1
Bombers	448	330	1.3:1
Attack aircraft	69	—	—
Reconnaissance aircraft	103	90	1.1:1
All aircraft	1,170	580	2:1

It must be noted at the same time that the German Air Forces were superior to the Soviet, as before, in the qualitative features of the aviation hardware and level of training of the flight personnel. This, by the way, did not hinder the winged defenders of Moscow from achieving an actual advantage over the enemy and his defeat in the air.

It was first and foremost the Hitlerites, and not just our own troops on the Western Front, that felt the increased activeness of Soviet aviation. It was stated at a conference of the commanding generals of the armies and chiefs of staff of the armies that was held under the leadership of the chief of the general staff of the ground forces, General F. Halder, on 13 Nov 41 in Orsha that the strong anti-aircraft defense had made Moscow almost invulnerable from the air, and that Soviet aviation was operating actively in the air for the first time since the start of the incursion.

During the period of the counter-offensive our Air Forces were given the missions of destroying the manpower and equipment of the enemy in tactical depth of his defenses, maintaining air superiority, providing solid cover for the attacking forces, preventing the enemy from bringing up reserves to the front, destroying railroad facilities in operational depth in his defenses, disrupting command, control and communications and performing reconnaissance. The principal efforts of aviation were concentrated on assisting the ground troops in routing the enemy's northern groups.

The troops on the left flank of the Kalinin Front went over to the counter-offensive at dawn on 5 Dec 41, and so did shock forces from the Western and Southwestern fronts the next day. The offensive zone was about a thousand kilometers wide and ran from Kalinin to Yelets.

Our aviation carried out 560 aircraft sorties over 12 days of battles, assisting the troops of the left flank of the Kalinin Front in advancing some 15-30 km. They shifted their strikes against the retreating troops on roads after the breakthrough of the tactical zone of the enemy defense, and covered their own troops and fords across the Volga while performing aerial reconnaissance.

Aviation preparation was able to facilitate the offensive of our troops on the right flank of the Western Front, in the course of which 150 sorties were flown. Headquarters, communications centers and enemy reserves in the sectors of main strikes by our troops were chiefly subjected to bombing. A strike was carried out simultaneously against enemy airfields in the area of Klin and Vatulino. Soviet aviation in the Western Front zone, operating at maximum intensity, made up to 800 sorties in the first three days of the counter-offensive.

Enemy aviation in small groups tried to bomb our offensive forces, but encountering strong opposition from Soviet fighters they were not able to impede substantially the offensive of the Red Army. Our fliers

made more than 3,600 aircraft sorties over ten days in order to support the troops of the Western Front.

Documentary data testifies to the complete sway of Soviet aviation in the course of the counter-offensive. It was noted in the operational report of the German Army Group Center for December 7, for instance, "the aerial situation: a multitude of air raids with the dropping of bombs and strafing of troop columns with on-board weapons...;" "There have been many raids by bombers on our artillery positions...;" The command of the 2nd German Army reported to the headquarters of Army Group Center on December 10, "the aerial situation: despite the bad weather, a multitude of attacks by enemy attack aircraft on the combat formations of units... has continued."

The troops of the Kalinin, Western and right flank of the Southwestern fronts continued to press the enemy regardless of the attempts of the fascist German command to halt the Red Army offensive. Aviation rendered considerable assistance to the ground troops. The main efforts of the Soviet Air Forces in the western sector were concentrated on smashing the principal enemy grouping in the area of the cities of Klin, Solnechnogorsk and Istra. Our aviation made 10,150 sorties from December 6 to 24 alone, of which 4,176 were to attack enemy troops. Soviet pilots waged 112 aerial battles over that same period, in which 103 hostile aircraft were shot down. Another 14 were destroyed and 27 damaged at airfields, while anti-aircraft fire brought down 49 German aircraft.

Enemy aviation thus suffered losses of 193 aircraft—a third of all his hardware on hand in the Moscow area by the start of our counter-offensive. The large losses has a substantial effect on the activeness of the Hitlerite aviation. A report by the command of the 4th German Panzer Army said that "Enemy aviation appears unexpectedly in groups of 30 aircraft, drops a large quantity of bombs and strafes intensively from the aircraft, while at the same time our aviation appears in a group of 3-4 aircraft once every 3-4 days."

German aviation was able to make only 2,000 sorties to support their own troops retreating under the onslaught of the Red Army from December 6 through 26 in the Moscow sector, which was five times less than the quantity of sorties by our aviation.

The German supreme high command was able to become convinced from their own experience, for the first time since the start of World War II, how difficult it was to control retreating troops under conditions of enemy air superiority. Urgent steps were taken to strengthen the Luftwaffe groups. A directive of the German supreme high command of 16 Dec 41 to the commander-in-chief of the air forces ordered the immediate redeployment of four bomber air groups and one fighter air group from Germany and the West to join the 8th Air Corps supporting Army Group Center, as well as the supplementing of that corps with fighters.

This was not that easy to do, however—by the end of December 1941 the Luftwaffe had 3,306 aircraft, of which only 1,462 were battleworthy. The Hitlerite aviation did not have such a small number of craft again over the whole period from the start of World War II until 1945.

The counter-offensive of the troops of the three fronts in the Moscow sector lasted 33 days. The Soviet Air Forces made some 16,000 sorties over that period under exceptionally difficult winter conditions, of which 46.5 percent were for the destruction of enemy troops and combat equipment.

The situation at the Soviet-German front looked as follows by the beginning of 1942: from the Barents Sea to Leningrad the sides had gone over to the defensive; in the northwestern sector the Soviet troops were preparing to break through the blockade of Leningrad and rout Army Group North. In the central sector the troops of the Kalinin, Western and Bryansk fronts were continuing the counter-offensive. The troops of the Southwestern and Southern fronts, continuing to hold Sevastopol and the Kerch Peninsula, were tying down major enemy forces.

Under these conditions Headquarters, Supreme High Command made the decision to develop the success of our troops around Moscow, Tikhvin and Rostov into a broad offensive on the entire Soviet-German front.

The aerial situation that had taken shape in the western sector by the start of January 1942 was typified by the fact that the quantitative superiority of Soviet aviation had increased somewhat. The Hitlerites had 615 aircraft versus our 1,422. The advantage that had been gained made it possible to utilize aviation with greater effectiveness, including in support of the ground forces.

The enemy, covering the retreat of his forces, offered strong resistance to our aviation with his anti-aircraft weapons. The fascists, having now lost their superiority in the air, preserved a quite high combat activity. They carried out strikes against Soviet troops and airfields close to the front lines by solitary aircraft or small groups of bombers.

It must be noted that additional difficulties arose for our fliers to the extent of the further forward advance. There were virtually no airfields suitable for basing in the regions liberated from the enemy. They had to rebuild those that had been destroyed by the occupiers. But the rear services of the Air Forces were not fully outfitted with personnel, equipment or matériel. All of this could not help but have an effect on their readiness for the acceptance and normal support of the combat activity of the aviation units.

January and February 1942 were especially strained for the Air Forces personnel of the Western Front. The air-defense fighter aviation could give less and less assistance to the frontal aviation as the front line

moved further and further from Moscow, although in February the 6th Air-Defense Fighter Corps waged 100 aerial battles and shot down 54 hostile aircraft, and in March 48 battles and another 25 [hostile aircraft downed].

Soviet aviation won air supremacy and held it until the end of the battle as the result of heavy and stubborn fighting against a strong and experienced aerial enemy. This was able to be achieved as the result of the quantitative correlation of forces during the course of the battles in favor of Soviet aviation, especially in fighters, and the high morale of the personnel of our Air Forces.

Soviet aviation carried out 49,235 aircraft sorties in all over the period of the general offensive (Table 2).

Table 2—Distribution of Efforts of Aviation by Combat Missions

Total aircraft combat sorties	49,235
for reconnaissance	2,089
against troops and equipment	22,179
against railroad targets	5,531
battle for air supremacy:	
—total	19,436
—against airfields	1,680
—for cover	15,749
—escort	1,976
—interception	31

The air forces of the Reich on the Soviet-German front numbered just 646 combat aircraft in the middle of March 1942. The authors of the anthology "World War 1939-1945," published in Germany in 1957, described the state of the German air forces by the end of the campaign as the "breakdown" of the Luftwaffe.

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Use of Satellite Reconnaissance in Gulf War

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pp 42-43

[Article by Candidate of Military Sciences Colonel V. Romanov under the rubric "Space Science—Military Aspects": "Over the Gulf"]

[Text] Analysis of the combat operations in the Persian Gulf testifies to the widespread utilization of space hardware by the multinational forces (MNF). It is

enough to say that by the time of redeployment of the alliance troops to Saudi Arabia, the military command already had a complete picture of the development of events in that region. The space imaging apparatus (electro-optical and radar) of U.S. reconnaissance had made more than four hundred passes over the territory of Iraq and Kuwait by that time. That made it possible to support the observation of fifteen thousand targets (with a resolution of fractions of a meter). Virtually all targets of the ground forces, the basing system of the air forces and missile units and subunits, as well as enterprises in the defense industry, were uncovered. Subunits equipped with the latest hardware were singled out among the ground forces, air forces and naval units as the paramount strike targets.

The orbiting group of U.S. space assets numbered some 29 surveillance platforms by the start of combat operations. We will consider their capabilities and use in the Desert Storm operation.

Three KH-11 electro-optic satellites were intended for the spectrozonal surveillance of targets on the Earth's surface, including in portions of the infrared band. The use of digital methods made it possible to transmit an image in virtually real time. The KH-11 spacecraft could conduct either a survey scan in a strip of 2,500 km or a detailed reconnaissance along the same strip of several zones with an area of about 10 square kilometers apiece.

The survey scan, in the evaluation of American specialists, makes it possible to identify the class of military hardware (tank, APC, truck etc.), while the detail shows the side number of a tank or determines whether a truck is carrying people or ammunition.

The Lacrosse all-weather radar reconnaissance spacecraft conducts surveillance of assigned targets around the clock under any weather conditions, but with worse resolution than the electro-optical reconnaissance spacecraft. It can perform reconnaissance of one or several zones in a strip of about 500 km in one pass over the target (zone). A powerful radar (the span of its phased-array antenna exceeds 20 meters) makes it possible to identify targets that are camouflaged by leaves, camouflage nets etc. The information received by the Lacrosse radar spacecraft is synthesized with the aid of a computer into images that are analogous to conventional photographs. Combat vehicles can be identified by class, and the quantity and coordinates of targets determined according to it.

Three Ferret electronic intelligence craft make it possible to detect the signals of enemy air-defense radars and control air traffic. The satellites in this orbital group are placed in circular orbits with an inclination of 96.5° and an average altitude of 700 km. The entire range of frequencies being covered of 50-18,000 MHz is broken down into seven subbands. Three or four narrow-band receivers are installed on each spacecraft, able to receive the electronic emissions of electronic equipment from a circular area of 3,600 km in diameter and determine

their location with a precision of 10-20 km. The direction finders of two or three satellites are thus able to receive electronic emissions across the entire frequency range. The information, recorded on magnetic tape (with continuous recording over three hours), is transmitted along radio channels through command, control and receiving posts to the Strategic Intelligence Center of SAC headquarters for processing.

Reconnaissance data from the Ferret satellites (up to 12 passes over the region a day) was "dropped" directly to a ground station located in Saudi Arabia for the purpose of raising efficiency during the conflict.

Surveillance of the water surface situation was accomplished by four groups of four electronic reconnaissance spacecraft for the oceans and seas called NOSS/Ssu. The Ssu satellites were launched in conjunction with the NOSS satellites and are located in orbit at a distance of 30-260 km from each other. This structure for the group makes it possible to determine the coordinates of surface ships using the interferometer method with a precision of 3-5 kilometers. The availability of this group makes it possible not only to survey any ocean over 1.5-2.5 hours, but also to receive the emissions of shipboard electronics in the range of 50-40,000 MHz. All of the information is stored in memory devices on the spacecraft and is transmitted by radio channel to ground and ship stations for the reception of intelligence data.

Four Shalle/Vortex electronic intelligence satellites and two Aquacade integrated electronic surveillance satellites provided for the intercept of the signals of radio-relay, tropospheric and ultra-shortwave communications stations in the frequency range of 20-40,000 MHz. These craft are placed, as a rule, in quasi-stationary orbits in order to increase the likelihood of intercept of electronic emissions from highly directional antennas. The diameter of the antenna of late models of the Aquacade spacecraft in particular reaches 100 meters. The satellite on-board gear made it possible to detect and determine the location of electronic equipment and to conduct the simultaneous intercept of conversations on 2,000 radio-telephone channels.

The MNF command devoted particular attention to information on the command and control system of the Iraqi troops, and first and foremost the air defenses and the operating modes of electronic equipment. Monitoring of the electronic situation was ensured via the intercept of radio and radio-relay communications lines and television channels, and all of this made it possible to determine the properties, operating modes and locations of the emitting objects.

The Landsat (United States) and Spot (France) satellites for researching the natural resources of the Earth were also brought in to expand the operational capabilities of imaging reconnaissance. The former is able to conduct economic surveillance and assess the results of the use of nuclear, chemical or biological weapons. It is placed in a circular orbit with an altitude on the order of 700 km,

and has a field of view of about 200 km with resolution of 30 meters. The latter has several better features (field of view of 900 km and resolution of 10 meters).

All of the intelligence data from the visual imaging satellites was transmitted to Fort Bellevue (United States), the electronic and radio data to the Main Center for the Control, Receiving and Processing of Information and the electronic-surveillance data to Fort Meade (United States). It was then transmitted from those main centers to the National Surveillance Intelligence Processing Center (Washington). The Tencap system, supporting the passing of the information initially received from the intelligence spacecraft to command and control stations at the tactical level, also successfully underwent testing in the course of the combat operations. A far-flung network of mobile receiving stations deployed in the zone and the widespread use of satellite communications allowed the MNF command to ensure high efficiency in passing the data from space reconnaissance to the troops (1.5-2.5 hours). A group for the use of spacecraft and distribution of the information being received from space in the conflict zone was also created at the headquarters of the Joint Central Command.

The U.S. Space Command also worked out new tactical methods for the use of space reconnaissance satellites during the course of combat operations. The possibility of utilizing the data from the space system for the detection of ballistic missile launches to destroy them with the aid of the Patriot air-defense missile systems was verified in particular. Information from the AWACS long-range radar detection aircraft was usually used routinely for fighting such missiles. The (Imeyus) spacecraft detected the Iraqi missiles (at altitudes above 15 km) roughly 30 seconds after launch. The joint use of the space-based ballistic-missile launch detection system and the Patriot air-defense missile system for the purposes of air defense, in the assessment of American specialists, could facilitate to a considerable extent the popularization of the SDI program, which remains a major nationwide program of the United States.

The drawbacks of an organizational and technical nature that are characteristic of contemporary space weapons, however, were also revealed along with the large contribution of the reconnaissance satellites to raising the combat effectiveness of the MNF. These include the capabilities for uncovering camouflaged targets, the lack of satellites for wide-panorama surveillance and planning the application of these systems.

The conflict in the Persian Gulf thus made it possible not only to test space hardware under real conditions, but also to obtain experience in their combat application and ascertain the directions for the further improvement of space hardware and methods of utilizing it therein.

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History of Early Soviet Attempt to Build Manned Lunar Spacecraft

92UM0898L Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 91 (signed to press 17 Dec 91) pp 44-45

[Article by Candidate of Technical Sciences V. Filin, deputy chief designer of the Energiya URKTS [universal rocket space transport system], under the rubric "By Reader Request": "The 'N1-L3' Project"]

[Text] Readers T. Samkharadze (Tbilisi), Yaroslav Ganne (Poland), V. Petrov (St. Petersburg), V. Solodkin (Kaluga), R. Gnatyuk (UkSSR), N. Ryabchikov (Tyumen Oblast) and other request a continuation of the story begun by cosmonaut and pilot A. Leonov (AVIATSIYA I KOSMONAVTIKA, 1990, No. 8) about the domestic moon program. We are fulfilling their request. Today the recollections of one of the direct participants in the creation of a Soviet lunar craft are offered for the attention of the reader.

So then, the government decree "The Creation of Powerful Launch Vehicles, Satellites and Spacecraft and the Assimilation of Outer Space" was adopted in 1960. Work began at the design bureau headed by Sergey Pavlovich Korolev on the design of the first Soviet launch vehicle in the superheavy class, which received the name of N1.

At the same time we, graduates of the MAI [Moscow Aviation Institute] gripped by the most diverse ideas, came to this organization, supporting the launch of the first artificial Earth satellite, the flights of the first automatic craft to the moon and Mars and, most importantly, the first flight of man into space.

S. Korolev was striving to come to a solution as quickly as possible on a more sweeping task—sending to Mars, in the first stage, an unmanned heavy interplanetary craft (TMK). It was namely under him that the N1 launch vehicle was designed. The mass of payload it would put into orbit at an altitude of about 200 km was initially planned at 70 tons. Reports began appearing in the press, however, about work in the United States on a project of national prestige—the manned lunar expedition Saturn-5/Apollo. The moon beckoned us as well.

And then the proposal was born to prepare the Soviet L3 manned lunar expedition based on the N1 launch vehicle. The point was that the assimilation of the moon was planned in three stages—its orbiting by a craft of the Soyuz type in an unmanned mode; its orbiting in a manned mode; and, the landing of expeditions.

The plans for the launch vehicle (N1) envisaged an increase in the nominal mass of the payload delivered to low orbit, first to 85 tons and then to 95. But that was in the long term, and at the time the developers were wracking their brains on how to keep within the strict framework of the power capabilities of the booster as

initially adopted. The search proceeded in every direction. The chief designer paid a bonus of 50-60 rubles for every kilogram of mass conserved or "found." That was a lot of money for us young engineers.

The N1-L3 program was the main one for Sergey Pavlovich, although it made its way with difficulty through the multitude of offices, commissions and councils. And only the reasoned arguments of Korolev and his reputation, along with the help of his comrades-in-arms, made it possible to clear all the hurdles. The order for it was received from the USSR Academy of Sciences, and it began to come to life.

The government decree "Work on Researching the Moon and Outer Space" was adopted on 3 Aug 64 and defined the deadline for the expedition—1967-68.

Before the end of the year we already had a conceptual design of the lunar craft that showed, in general outline, the possible ways of creating it. The requirements for the properties of the materials, the elemental base for the electronics and radio gear and the specific properties of the engines were posed as essential in them, but they had not yet been achieved.

Two years passed. The sad news came unexpectedly. Sergey Pavlovich Korolev had passed away. The cause that had been started was entrusted to his first deputy, Academician V. Mishin.

Vasiliy Pavlovich, for reasons incomprehensible to us, at first linked new design bureaus with the development of the lunar project, and then the question arose of its transfer to the enterprise of Chief Designer G. Babakin. This was doubtless a grave time for us who had "grown accustomed" to that craft. But to our joy, the project remained with us, and its detailed development began.

So just what was the N1-L3 project? I will begin my story about it with the N1 launch vehicle.

It utilized the traditional fuel components—liquid oxygen and kerosene—to put payloads into orbit. The launch vehicle consisted of three stages, including rocket units A, B and C. It also had the booster and booster-braking units D and E, which were to provide for the further flight of the craft to the moon and its entry into orbit as an artificial satellite of the moon (OISL). Then one of the two crew members would have crossed through open space from the lunar orbital craft (LOK) to the lunar craft (LK), after which the LK with the rocket unit E docked with it would move (with braking to an altitude of about three kilometers) to the moon's surface. The LK was then to turn on the engine of the rocket unit F of the craft at the command of the landing radar, and that would provide for the further reduction of speed and for maneuvering (hovering and selection of landing site) conducted with the participation of the cosmonaut. The latter was accomplished in the mode of heavy throttling (reduction) in the thrust of the engine of unit F right up to the lunar landing.

It is well known that any object is more stable with a low positioning of the center of mass. The heavy element has the greatest effect on the centrifugal characteristics in its configuration. And since it was the the rocket unit for the lunar craft, they began to "pound it down" in height. That is, they began to drive the engine of the unit inside the tanks. The oxidizer tank was transformed into a torus as a result.

The turn also came for the lunar landing device (LPU). We understood that the shock-absorbing "legs" should be self-contained in a strength regard with their own frame. The distance from the nozzle edge to the bearing frame on the oxidizer tank determined the dimensions of that frame. This dimension was a total of 600 mm. Preference was given to a version with ribs among a large quantity of frames.

The design configurations of the flight deck with the instrument compartment, the rocket unit and the frame of the LPU were determined as a result of the work performed. General questions were resolved at the same time—how should the lunar craft be controlled? How would it be launched from the moon? How could the thermal conditions, power, communications and access to the surface be provided for? etc.

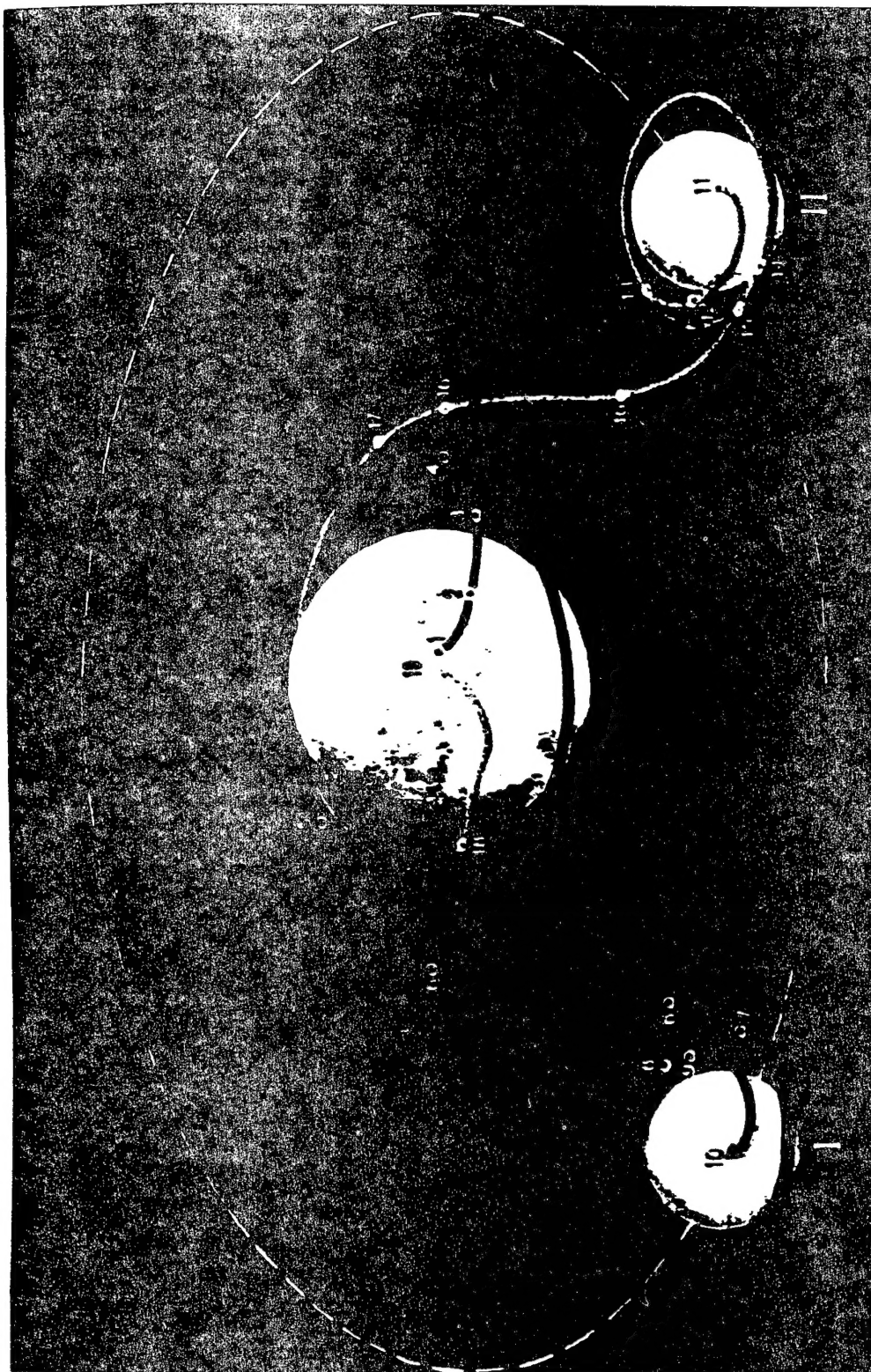
At first we were completely unable to imagine how to provide for a sure launch of the takeoff stage from the moon. The launch complexes common for Earth conditions were lacking there, after all. It was thus essential to utilize the same for the lunar landing device. The battle for its low center of gravity led to an increase in the transverse dimensions of the rocket unit, which had to be "buried" in the LPU once again.

The look of the craft was born in torment. Creativeness, inventiveness and originality of solutions were needed on any issue. The sword of Damocles—the limit for mass and the time limit—was hanging over us all.

A new docking device was needed after the launch of the takeoff stage of the LK and its return to the OISL for docking with the orbital craft, since the existing one—"probe and cone"—was not suitable. We decided to make this device a "passive" one on the lunar craft, and selected a flat cell design. This substantially eased the docking of the spacecraft, since each cell was a miniature "cone."

The choice and position of the electric-power elements proved to have a substantial effect on the look of the craft. The choice was conditioned by active work that was restricted to two days. We thus settled on chemical sources of current—batteries. They had to be accommodated both in the ascent and in the landing stages. They were installed on light frames—three batteries on the frame of the LPU and two on the outside in the instrument compartment.

The positioning of the landing radar, impressive in its dimensions, offered particular difficulties. Here we had to depart from the traditional round shapes for the



Key:

1. launch of N1 launch vehicle
2. separation of unit A
3. separation of unit B
4. separation of unit C
5. ignition of unit D. Entry onto trajectory for flight to moon. Separation of unit D.
6. correction of flight trajectory of lunar system using unit E
7. structure of lunar orbit by unit E
8. separation of lunar orbital craft
9. ignition of engines in unit E for braking the lunar craft. Separation of unit E
10. landing of lunar craft
11. launch of ascent stage of lunar craft
12. convergence of ascent stage of lunar craft with lunar orbital craft
13. docking of ascent stage of lunar craft with lunar orbital craft
14. separation of ascent stage
15. transition to flight trajectory to Earth. Engines of lunar orbital craft operating
16. correction of moon—Earth trajectory
17. separation of crew compartment for return to Earth
18. entry of crew compartment into atmosphere
19. landing of crew compartment on Earth's surface

airtight instrument compartment and accommodate the radar through its oval shape. The communications of the LK with the orbital craft and the Earth were provided for by antennas in the meter, decimeter and centimeter bands, for which no few original solutions were found. An umbilical tower that separated and retracted to a safe angle in the launch of the ascent stage was envisaged for the power and hydraulic communications of the ascent and landing stages.

The configuration of the pilot unit of the L3 on the launch vehicle was such that the lunar craft (with a height and maximum dimension between the supports of the landing device of more than five meters and an initial mass of 5.5 tons) was under the fairings of the transitional compartment and the lead fairing. The latter was to be jettisoned after traversing the dense layers of the Earth's atmosphere. Special guides were required to extract the craft, which was at considerable depth, and which were jettisoned after it was rolled out and the support "legs" were deployed into working position.

The craft was almost entirely covered with vacuum-shielded thermal insulation, which smoothed out its contours and ensured reliable thermal conditions.

There is no opportunity of describing all of the LK systems in detail. I would like to talk about certain of them, however.

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